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MACHINERY

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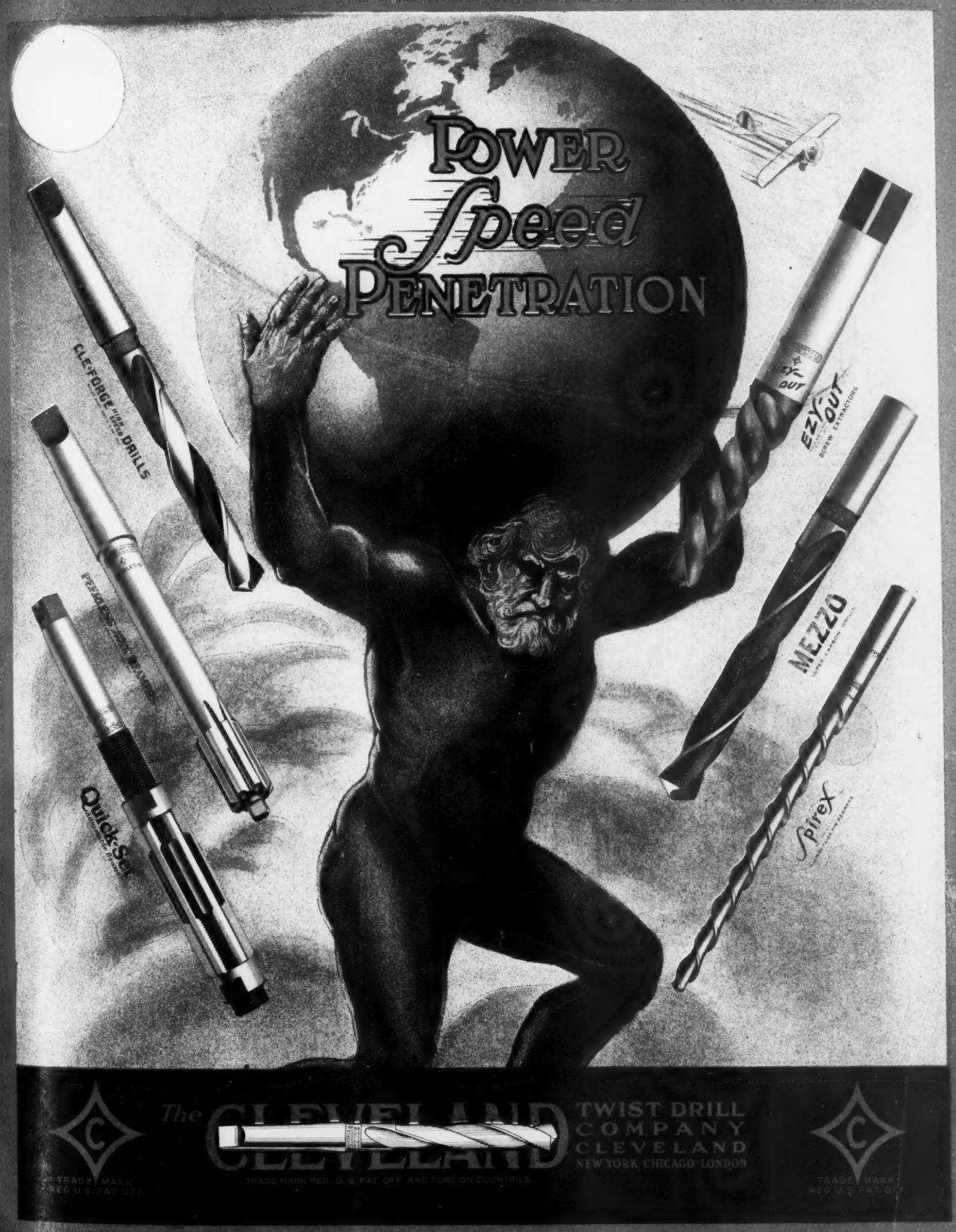

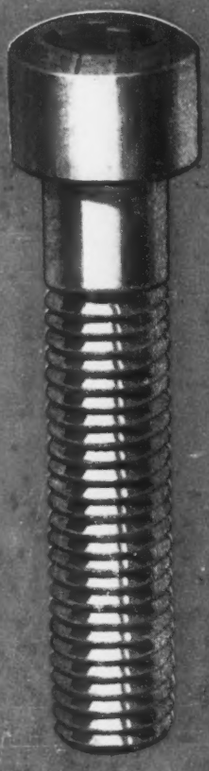

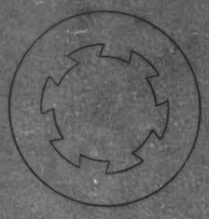

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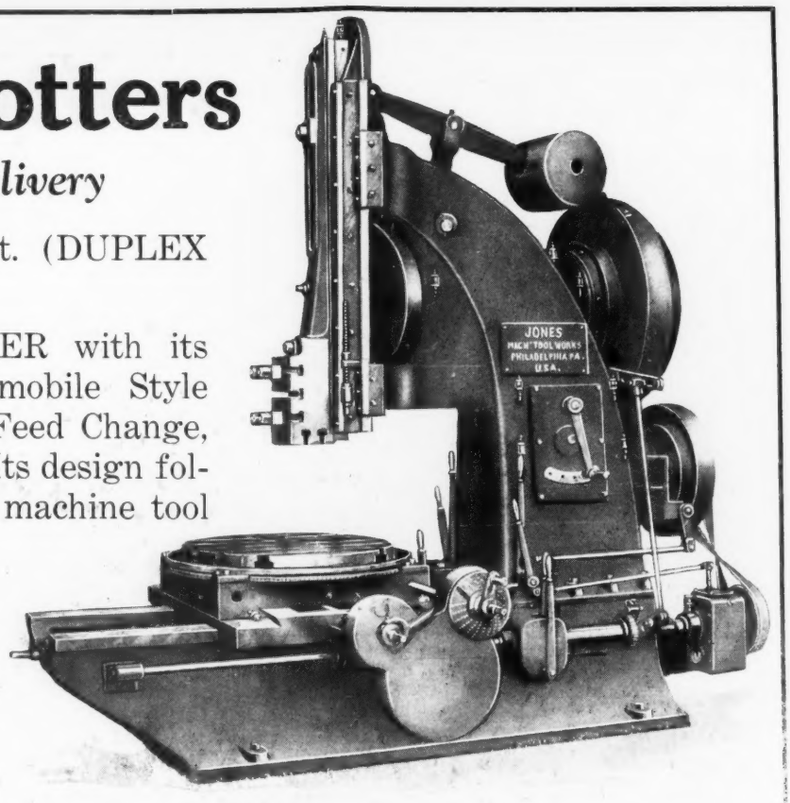

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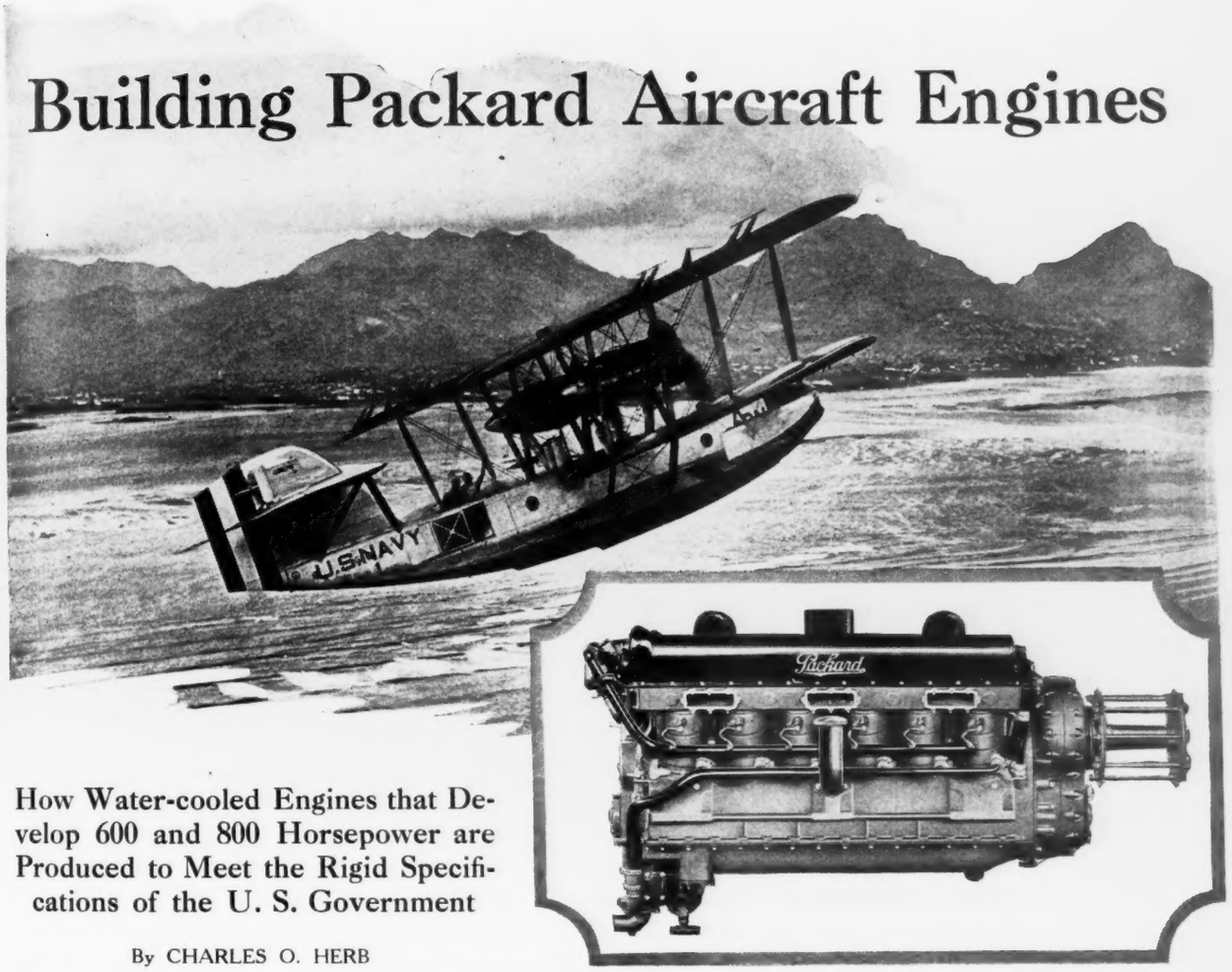


How Water-cooled Engines that Develop 600 and 800 Horsepower are Produced to Meet the Rigid Specifications of the U. S. Government

By CHARLES O. HERB

VAST improvements in engine design have contributed to the enormous strides made by aviation. The plane in which the Wright brothers accomplished their momentous flights back in 1903 was equipped with a four-cylinder water-cooled engine which developed only 12 horsepower. It weighed 170 pounds—approximately 14 pounds per horsepower developed. Recently the Packard Motor Car Co., Detroit, Mich., built a twenty-four cylinder water-cooled aircraft engine of X construction which develops 1250 horsepower with a crankshaft speed of 2700 revolutions per minute. This engine weighs 1402 pounds, which is equivalent to only 1 1/8 pounds per unit of horsepower.

The same company regularly manufactures, for air service, engines that attain 600 horsepower at 2500 revolutions per minute and 800 horsepower at 2000 revolutions per minute. Direct-driven models of these engines weigh 730 and 1150 pounds, respectively, the weight per horsepower developed being only about 1.2 pounds in the smaller engine and 1.4 pounds in the larger. The 600-horsepower engine is said to have the lowest specific weight of any aeronautical engine that ever passed the fifty-hour test of the United States Government. Although delivering 200 horsepower more than the famed Liberty engine of war days, it weighs 150 pounds less.

The 800-horsepower engine is particularly designed for use in heavy-duty flying boats and daylight bombing planes. It is sponsored by the United States Army. The smaller engine is used in scouting and fighting planes by the Navy Department. A Boeing pursuit plane equipped with this engine is shown in Fig. 15. This plane established a world's speed record for fully equipped planes by averaging 180 miles per hour over a triangular course. It is the type of airplane with which the Naval Department is equipping the great airplane carriers *Saratoga* and *Lexington*.

Both the 600- and 800-horsepower engines have twelve cylinders. They are each built with direct or geared drives, and the smaller size is also manufactured in an inverted model. An 800-horsepower engine of the geared type is shown in the insert of the heading illustration, the gear-box being at the right-hand end. This engine has a displacement of 2540 cubic inches, whereas the 600-horsepower engine has a displacement of 1530 cubic inches. Compactness of design is a feature of these models, in addition to power and lightness of weight.

Rigorous Specifications Followed in the Manufacture

Exceptionally close limits are specified on many of the engine parts, and an extra fine finish is required. Most parts are finished all over, both for

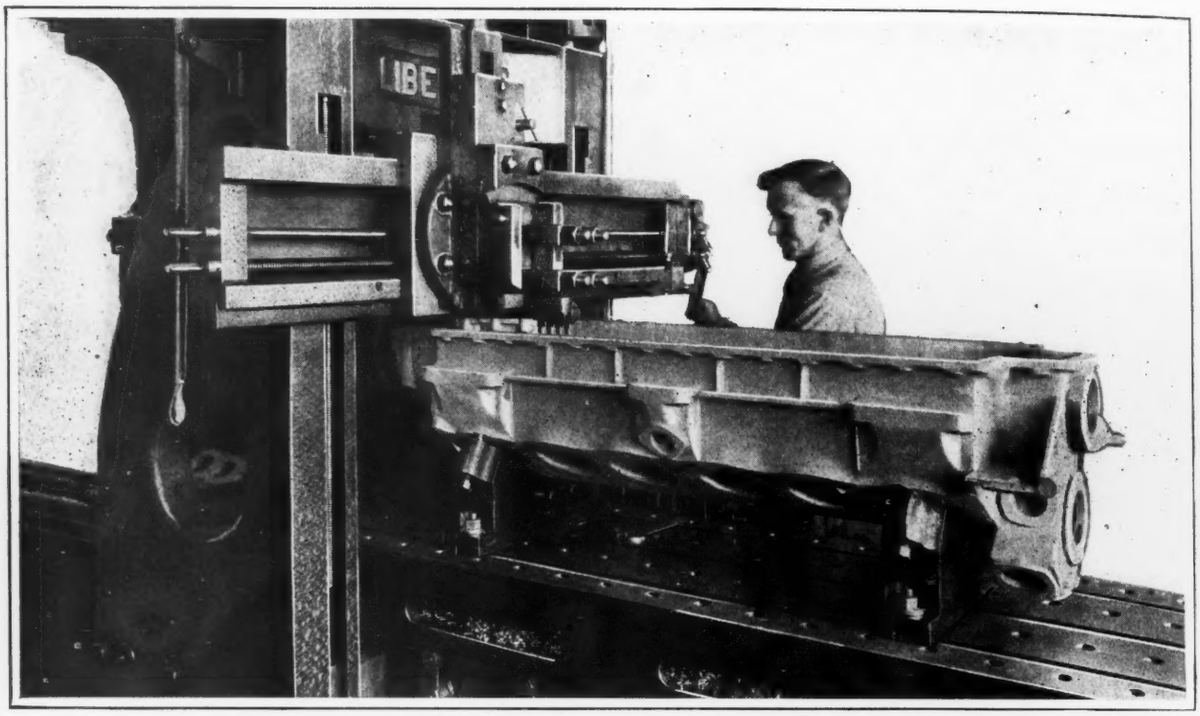


Fig. 1. Planing Various Surfaces of an Airplane Engine Crankcase by the Use of Four Tools in One Holder

the sake of appearance and in order to make the parts as light as possible, consistent with strength. Some of the interesting operations in the production of these engines are described in the following. High-production methods and highly specialized tooling are not generally used, because a production of 450 motors per year does not require them. The airplane engine department is equipped practically throughout with new machine tools. The use of standard machines promotes flexibility to meet contingencies arising from changes in the design of parts.

Important Operations on the Crankcase

Each cylinder of these airplane engines is a separate unit, comprising an inner steel sleeve, a steel combustion chamber, a steel head, and an enclosing sheet-metal water jacket. All these parts are welded together. The two six-cylinder units are assembled together at the upper ends on a heat-treated aluminum valve housing, while the lower ends are afterward bolted to a heat-treated aluminum crankcase. This construction permits any cylinder to be quickly disassembled when the engine is in service.

Four tools mounted in one holder are used, as shown in Fig. 1, for roughing and semi-finishing the flange that extends around the bottom of the crankcase, this being the first operation on the part. After one or two cuts, depending upon the stock thickness, have been taken on the flange with these four tools, a wide-faced tool is employed to remove about 0.005 inch of stock. While the crankcase is mounted on the planer table, cuts are also taken along the edges of the bottom flange and on various pads on the sides of the crankcase. It will be seen that the V-surfaces to which the cylinder units are later assembled are seated on adjustable plugs of V-supports fastened to the planer table. In setting up the crankcase, the height of the bottom flange above the table is checked at various points, and the supporting plugs are adjusted until the flange has been made level all around.

The surface of the crankcase to which the cylinders are later bolted, and various other surfaces as well, are finished in the adjustable rail-type milling machine illustrated in Fig. 2. Mounted on the machine table is a fixture in which the crankcase may be indexed into various angular positions to bring the different surfaces to be machined into the horizontal plane beneath the milling cutter. Three roughing cuts and two finishing cuts are taken on most surfaces. The cutter shown is large enough to span the width of the cylinder pads.

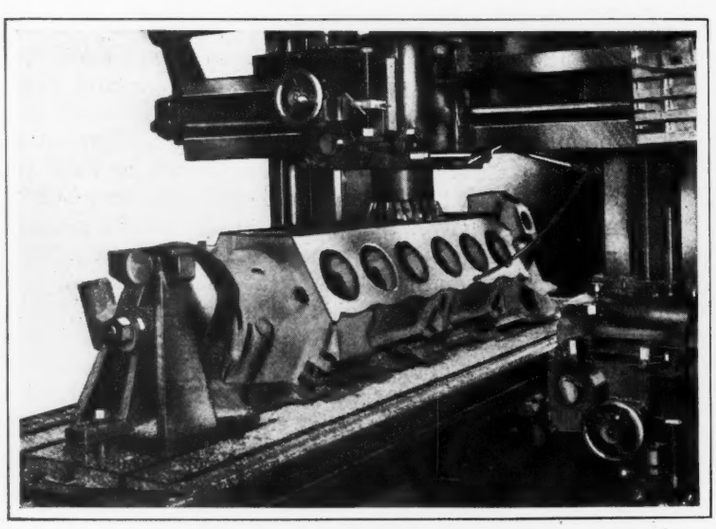


Fig. 2. Set-up Employed for Milling Cylinder Pads and Other Surfaces of the Crankcase

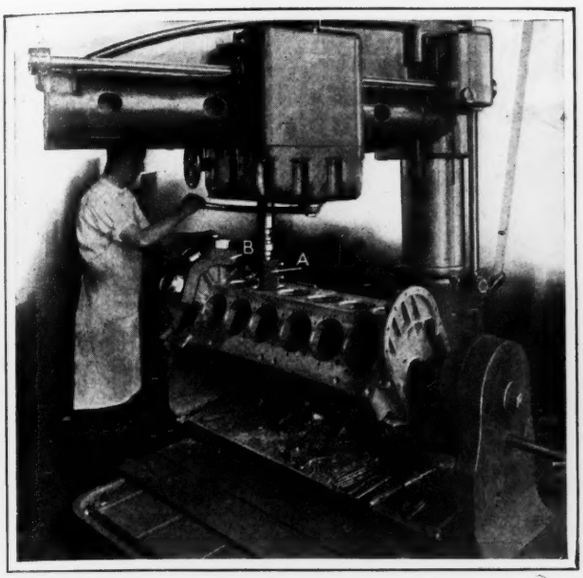


Fig. 3. Boring the Crankcase Cylinder Pad Holes

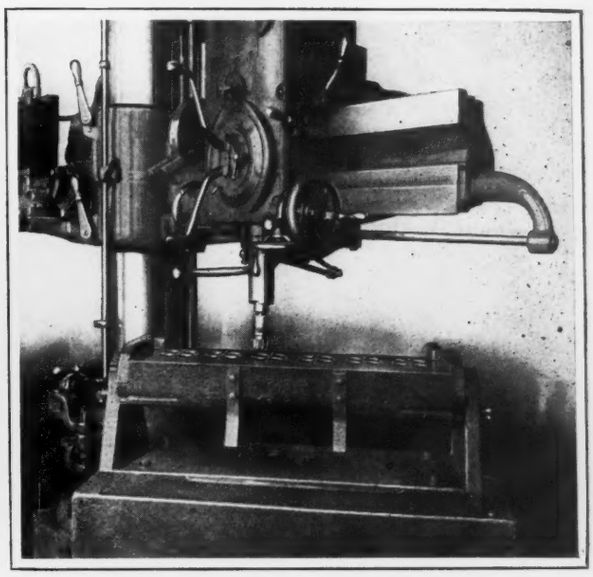


Fig. 4. Jig for Drilling and Boring 284 Holes

The bottom of the crankcase, previously finished, is used for locating purposes in this operation.

Radial drilling machines are extensively used in the airplane engine department. Fig. 3 illustrates this type of equipment being employed for machining the holes of the crankcase into which the cylinders fit. These holes must be accurate both as to diameter and center-to-center distance, because in the final assembly of each engine, all six cylinders of one side are slipped together into place over the pistons and connecting-rods previously assembled on the crankshaft.

In the operation of boring these cylinder pad holes, a bar *A* provided with three cutters is employed, and each hole is finished by one feeding movement of the bar. A pilot at the lower end of the bar enters bushings in the bottom of the jig to steady the tools while cutting. After all the cylinder pad holes on one side of the crankcase have been finished, the jig is indexed to bring the second line of holes into the horizontal plane. Hinged section *B* of the jig is swung into place as shown, and locked after the crankcase has been placed in the jig. This hinged section contains three bushings through which the boring-bars are fed to finish three holes at the far end of the crankcase.

Machining the Cylinders

The cylinder sleeves are forged from chrome-molybdenum steel and given a heat-treatment to increase their toughness before being delivered to the department. Various turning, boring, and facing cuts are taken on the sleeves in turret and engine lathes, after which they are sent to the welding section to have the various parts welded together, as already mentioned. The welded units are next delivered to the heat-treating department to undergo a normalizing process, and are then returned to the turret lathe shown in Fig. 8. Rough- and finish-boring cuts are taken in this machine to bring the bore to within about 0.023 inch of the finished diameter. It will be seen that the cylinder unit is held in a box chuck to which the flange near the bottom end of the cylinder is bolted. Cutting lubricant is fed directly to the cutting edge of the boring tools.

The profile of the flange of the lower end of each cylinder is milled to reduce the weight as much as possible and to produce a nice appearance. This operation is shown in Fig. 6. Before the work is placed in the machine, a large cam *A* is fastened to the flange. For the operation, one end of the cylinder is held on a large taper plug mounted on the machine spindle, while the other end is supported by a chuck on dividing head *B*. With cam *A* held constantly in contact with roller *C* through the action of a counterweight attached to the table, the dividing head rotates the work in contact with milling cutter *D*. Thus the cylinder flange is milled to the exact outline of the cam but to smaller dimensions. Power is delivered to the dividing head through pulley *E*.

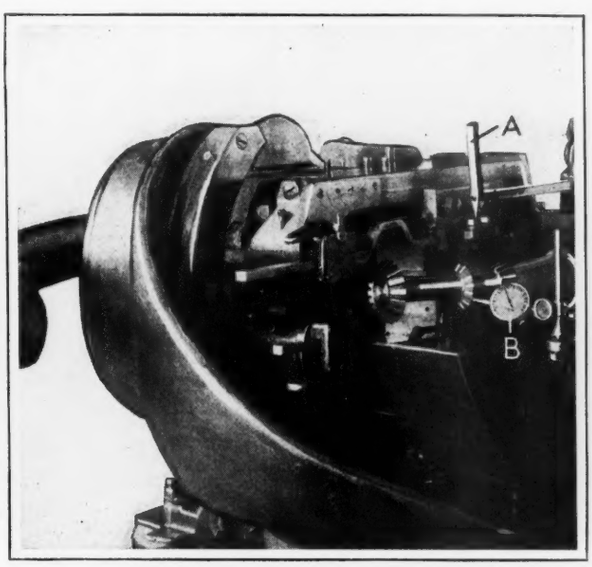


Fig. 5. A Typical Gear-cutting Operation

Chucking grinders are used as illustrated in Fig. 7 for grinding the bore of the cylinders to the specified diameter within plus or minus 0.001 inch, for a depth of about 10 inches. The bore must not be out of round more than 0.002 inch. The nominal bore diameter of cylinders for the 600-horsepower engine is 5 3/8 inches, and

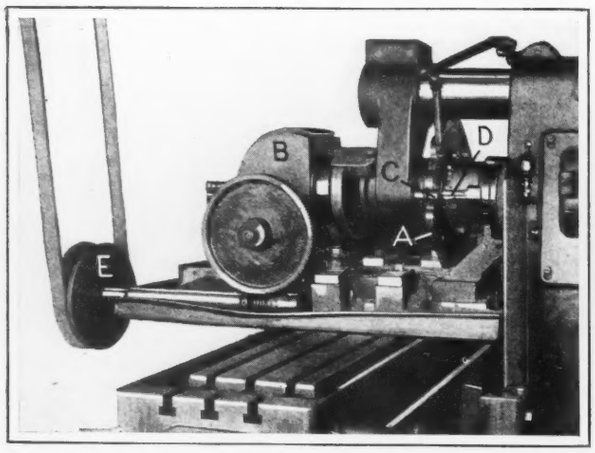


Fig. 6. Milling the Profile of a Cylinder Flange to the Outline of a Cam

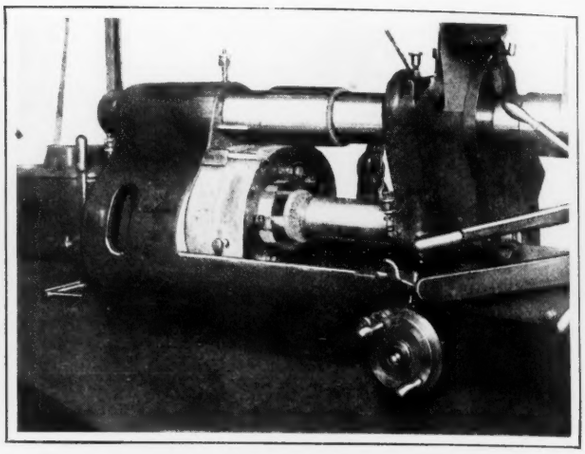


Fig. 7. Equipment Employed for the Finish-grinding Operation on the Cylinders

for the 800-horsepower engine, 6 3/8 inches. Four clamps are used to hold the cylinder in the chuck, and the operation is performed with the grinding spindle running at about 4300 revolutions per minute. Sal soda water is copiously supplied to the wheel and work. The accuracy of this operation is determined by means of a regular inside micrometer.

An Unusual Turret Lathe Job

A turret lathe operation of unusual interest consists of boring from the solid the four port holes of the cylinder heads. At *A*, Fig. 12, is shown a cylinder head which has had only one port hole and the surrounding boss machined, while at *B* is shown a head as it appears at the end of the operation. From the turret lathe the head goes to a machine in which it is moved horizontally beneath a milling cutter to remove all excess stock around the port bosses. Finally, the entire periphery of the head is finished in a Fellows gear shaper equipped with an ordinary shaper tool. The milling and shaping operations are employed only to remove as much stock as possible.

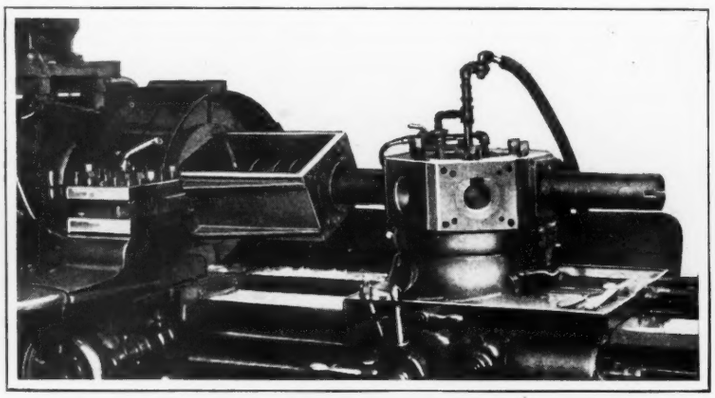


Fig. 8. Boring a Cylinder Unit in a Turret Lathe

When the head comes to the turret lathe, the four studs around the edge of the head and the one in the center have already been produced. The turret lathe chuck is of such a design that the cylinder head can be mounted in the four different positions necessary for producing the bores and their bosses. Six tools are used for each position of the work, but ten tools are required for each cylinder head, as two of

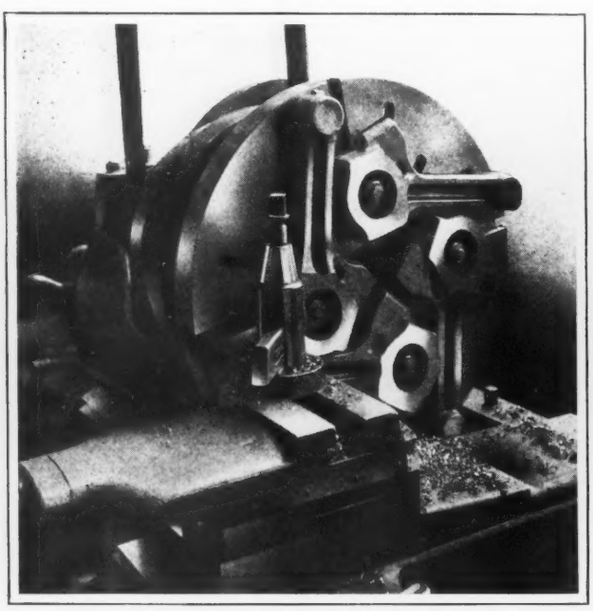


Fig. 9. One of Many Engine Lathe Operations

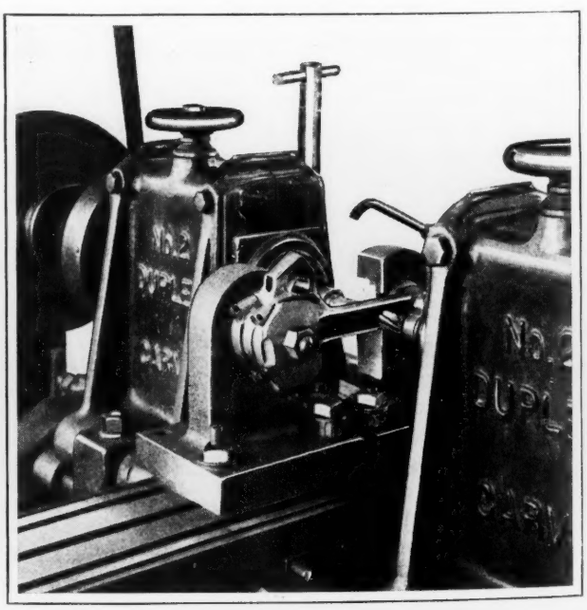


Fig. 10. Finish-milling Channels of Connecting-rod

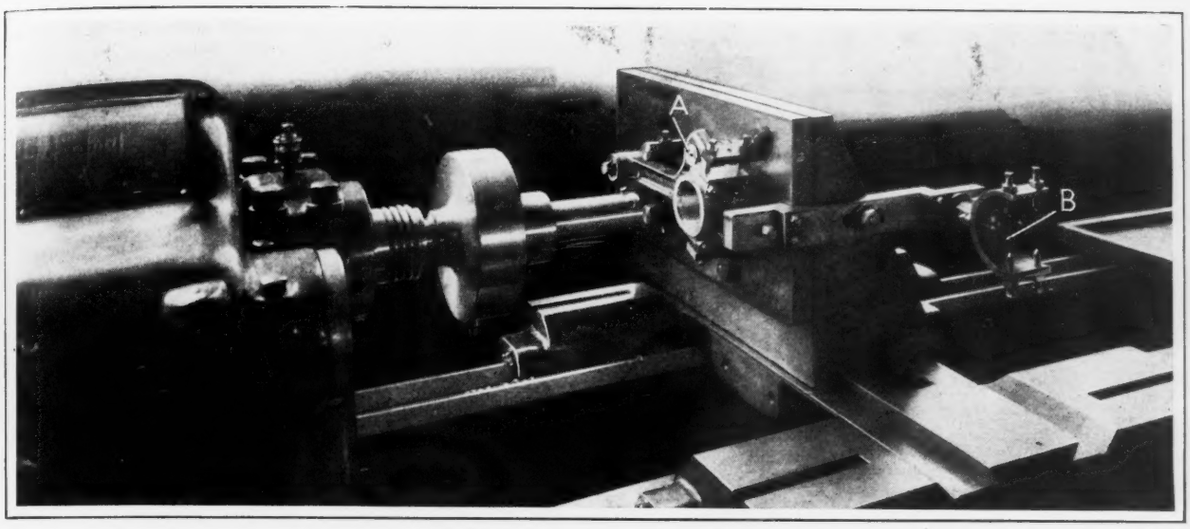


Fig. 11. Equipment by Means of which Both the Main and Wrist-pin Bearings of Connecting-rods are Diamond-bored

the ports are 2 inches in diameter, while the other two ports are 2 1/4 inches in diameter.

In the first step of each operation, the turret is advanced to center-drill for the port hole. Then a 1-inch drill and either a 2- or 2 1/4-inch drill on different faces of the turret are advanced successively to produce the port hole. Next, a facing tool is advanced to under-cut the face of the port boss; after this step, two hollow mills of special design are successively employed to cut the groove which forms the port boss. The first of these hollow mills is provided with straight tool blades, while the blades of the other hollow mill are shaped to a radius.

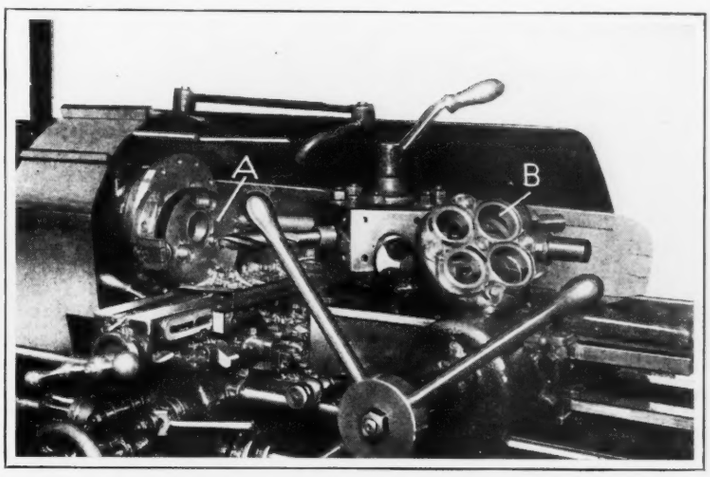


Fig. 12. Machining Four Port Holes and Their Bosses from Solid Steel

The connecting-rods are also forged from chrome-molybdenum steel and are finished all over. When finished, they must not vary more than 3/4 ounce, the weight of a master rod for the 800-horsepower engine being 8 pounds 15 ounces. Facing the sides of both bosses comprises the first operation; this is done on an engine lathe, as shown in Fig. 9. Each rod is held on the faceplate of this machine by slipping the main bearing over a stud fastened to the faceplate and

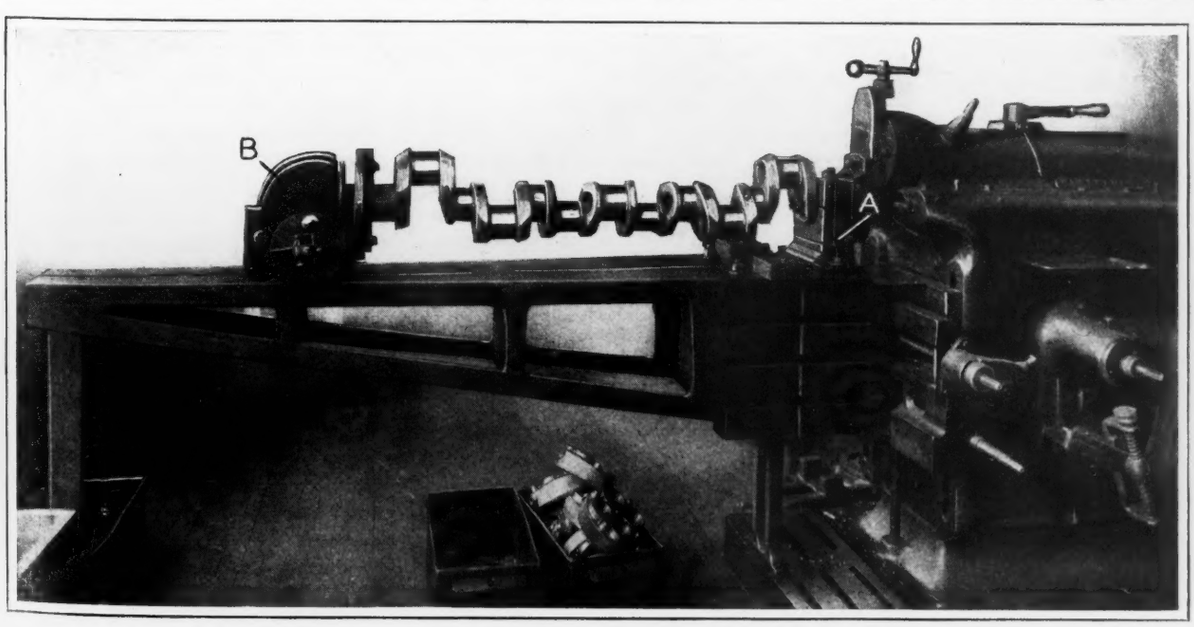


Fig. 13. Unusual Set-up Employed for Shaping Splines in One of the Crankshaft End Bearings

Fig. 14. Centralized Inspection Department in which All Parts are Checked

then tightening a nut on the stud. Both the main and wrist-pin bosses of the rods are of the same thickness, and so the two ends are firmly supported for the cuts. After both bosses have been faced on one side, the rods are turned over for facing the opposite side. Before this operation on the connecting-rods, they are heat-treated to obtain a hardness of between 300 and 340 Brinell.

The channels of the connecting-rods are finished by end-milling in a machine of the type shown in Fig. 10, two cutters being employed so as to mill both channels simultaneously. The two ends of the rod are clamped to a fixture on the table, after which the cutter-heads are fed toward each other until the proper depth of channel has been reached. The table is then fed transversely to carry the rod past the cutters.

After the main bearing of the connecting-rods has been babbitted and a bronze bushing has been pressed into the wrist-pin bearing, both bearings are bored in the lathe shown in Fig. 11. For the operation on the main bearing, the rod is located by slipping the link-pin bearing over plug *A* and fitting the wrist-pin bearing over a similar plug, both bearings having been previously finished to within 0.020 inch of their finished dimensions. Various screws are then adjusted to support the rod in the middle of the arm and at the main bearing end.

With a connecting-rod set up as described, a high-speed steel tool is employed to take two cuts on the main bearing, and then a diamond tool is used in the bar shown to remove from 0.010 to 0.012 inch of stock. The limits on the diameter of the bearing are plus or minus 0.00025 inch and the walls must be parallel within 0.003 inch on a length of 5 inches. Device *B* is used to support the connecting-rod when boring the wrist-pin hole, in which case the main bearing end extends toward the rear of the machine and the wrist-pin bearing is in line with the machine spindle.

Jig for Almost 300 Holes

Drilling and boring operations on a total of 284 holes are accurately performed on the aluminum valve housing by means of the equipment shown in Fig. 4. The work is entirely enclosed by the jig and the latter can be indexed to bring each side uppermost. A hinged side of the jig is swung open to permit loading and unloading and is locked in the closed position by means of C-clamps. When the photograph was taken, the operation in progress consisted of reaming one of the twenty-four valve holes. A quick-change chuck enables rapid substitution of tools.

The crankshafts are ground all over and accurately balanced by conventional methods. The cutting of four splines in one end bearing of the crankshaft, however, is effected by means of the unusual set-up illustrated in Fig. 13. The bearing in which the splines are machined is accurately held in a rest *A* close to the shaper, while the other end of the crankshaft is supported by a dividing head *B* located on an auxiliary beam mounted on the shaper table. Indexing for the splines is readily accomplished by

Fig. 15. Pursuit Plane which Established a World's Speed Record by Averaging 180 Miles per Hour Over a Closed Course

means of the dividing head. The tool is ground to the desired shape of the splines and is mounted in a round bar attached to the tool-block of the shaper ram. The ram stroke, of course, is slightly longer than the length of the splines.

Three bevel gears integral with one shaft are cut in the machine shown in Fig. 5. The practice is to cut one gear on a group of shafts, then run the same group through the machine again to cut the second gear, and finally, run the group through a third time to cut the last gear. As the gears differ in number of teeth, pitch, etc., the cutter set-up must be changed each time. The work is adequately supported by extending the shaft of the gears about 4 inches into a draw-back collet chuck.

Before the gear shaft comes to the machine, a locating line is scribed on a copper-plated surface of both the front and back gear. When the shaft is inserted in the chuck, these lines are registered directly beneath pointer *A* before the chuck is tightened. The pointer is so arranged that it may be swung into contact with the gears. Indicator *B* is employed before an operation is started to make sure that each gear will index true.

Inspections and Final Tests are Exact

All parts are brought to the centralized inspection department shown in Fig. 14 for checking before being sent to the assembly department. Exceptionally high-grade men are employed for this department, as they must rely upon their own resources in checking many parts. There is an adequate supply of standard gages, but few special gaging devices. The table in the foreground shows a number of cylinder units; the second man in the illustration is engaged in checking a valve housing.

After each engine has been assembled, it is sent to a test room for a preliminary test in which all bearings are thoroughly "run in." The engine is first driven through an electric dynamometer for three hours at 1000 revolutions per minute. Then it is run under its own power, driving the dynamometer, and the speed is gradually increased over a period of two hours until the normal speed is reached and 90 per cent of the rated power is registered. The normal speed is either 2000 or 2500 revolutions per minute.

When the engine has been run for 1 1/2 hours at the normal speed and at 90 per cent of the rated power, the throttle is opened the maximum amount for thirty minutes, still maintaining the normal speed. The engine is next removed from the test block and disassembled to permit careful inspection of all working parts. During this period, the various parts of the water circulation system are tested, all valves are looked over, all bearings are reburnished, etc. Government inspection begins with the end of the preliminary test.

When the engine is on the test stand, one end is connected to the driving motor and the other end to a shaft that extends first through a water brake and then through the electric dynamometer. The dynamometer is of 200-horsepower capacity and has enough power to start up the engine, the motor not having sufficient power to start up the 800-horsepower engines. The water brake is used to dissipate the power when the engine is running itself. Through this brake, the speed can be controlled within 10 or 15 revolutions per minute even at the high speeds at which the engine is run.

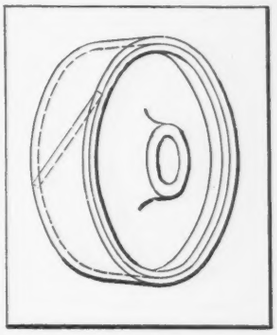
After the engine has been reassembled, it is placed in the final test, using the same equipment as in the preliminary test. In the final test, the engine is run from 45 minutes to 1 hour at a speed of about 1000 revolutions per minute, and then the speed is gradually advanced over a period of an hour until the normal speed is reached, while obtaining 90 per cent of the rated power. The engine is operated under these conditions for thirty minutes and then the throttle is again opened wide for thirty minutes with the engine making the normal number of revolutions. The engine is then taken off the test stand. During the last thirty-minute period of the test, the power is checked, and the oil and gasoline consumption is calculated over the last sixty minutes.

* * *

ENLARGING DIAMETER OF PULLEY

By W. S. BROWN

Most people in the engineering profession are familiar with the use of paper in the construction of gear pinions and pulleys, but the use of paper as described in the following is somewhat of a novelty. Difficulty was experienced in reducing the speed of a tumbling barrel, for small brass castings, to a point that would give effective cleaning and yet keep the speed as high as possible. The desired result was within a step of attainment, when it was found impossible to obtain a pulley of exactly the right size. As time was limited, the diameter of one of the pulleys was increased slightly by employing the age-old patternmaker's kink of gluing cardboard around the pulley. Ordinary box cardboard and common glue were used, the joints at the ends being spliced, as shown in the illustration, in order to provide an overlap without an uneven surface.



Pulley with Cardboard Applied to Increase Diameter

The layers of cardboard were about 1/8 inch thick, and were arranged with the joints staggered. An addition of about 1 1/2 inches was made to the original 8-inch diameter of the pulley, which had a face width of 2 inches. Although the amount added to the diameter of the pulley gave the required result, it was obvious that the size could have been increased considerably more.

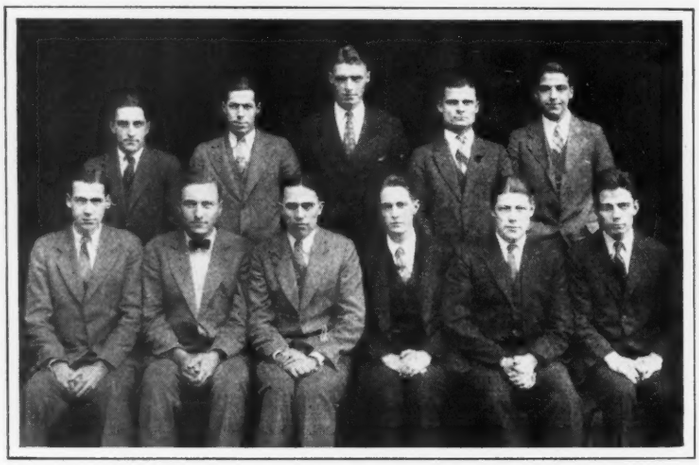
No rivets or fastening means other than the glue were used, although the addition of a few copper rivets would doubtless have added to the load-carrying capacity and safety factor, especially at high speeds. After the cardboard had been glued in place, it was clamped to the pulley by encircling bands until the glue had become set. The service rendered by the enlarged pulley has been so satisfactory that there has been no occasion to replace it with a regular commercial product.

Training Men for Shop Management

By W. D. STEARNS, Superintendent of Personnel, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

FACTORY managers are recognizing more and more the desirability of having a considerable number of men with an engineering education in their organizations. A man does not necessarily need to go to college to obtain an engineering education, although probably that is the easiest way to obtain it. However, sometimes the easiest way is not the best way. The man who gets his education at college frequently suffers in comparison with the man who obtains its equivalent in the "school of hard knocks," because after he has graduated, it sometimes takes him quite a while to obtain the right mental attitude toward his work and his fellow workers.

Most of the large companies have for many years provided training for young men for sales and designing engineering work. Few, however, have done much in the way of systematized training for the men who will later be called upon to take supervisory positions in the factory organization. These positions have usually been filled from the ranks. Often a man has been called upon to assume responsibilities that demanded a general knowledge of many phases of management. The man has come up through only one department of the factory and is badly handicapped, because he lacks training and experience in other lines of work. Factory management is no longer looked upon as something in which experience can be obtained in a haphazard manner. It demands men of mental capacity and good judgment, as well as broad experience.



A Group of College Graduates who Took the Westinghouse Works Management Course Last Year

What Previous Training Should a Man Have Who is Fitting Himself for a Management Position?

When a large organization undertakes to train men for shop positions, the first thing to do is to get the men to be trained. This brings up the question of previous experience, age, and adaptability. What background should a man have for positions of this kind? The author of this article believes that a man may, and frequently does, obtain the desired preparation without going to college, but because college graduates seem to furnish the most natural supply of men to be trained for works management, these men are generally given consideration.

The previous training that is of most value is that which develops the man the most. It is not the specific knowledge obtained in college that counts, but rather, the training that has developed in him the ability to (1) Get the facts and know that they are facts; (2) get all the facts that bear directly on the subject in question; (3) arrange these facts in a logical order; (4) draw true conclusions from the facts and pass sound judgment based on facts; (5) having determined what should be done, get it done in the easiest and most satisfactory way; and (6) use the abilities of others to the best advantage.

Why College Training is of Advantage

Briefly, a man's college training is valuable to him because it teaches him to think straight, to act logically, and to so deal with men as to obtain their help and cooperation. It develops the capacity for teamwork.

The engineering college seems to give the training most likely to develop the qualities enumerated, and perhaps the mechanical engineering course is the one best fitted to do this, because most of the subjects that are taught in that course impart information that is likely to be of direct use, although, as previously stated, imparting information should not be the chief aim of education. The chief aim is rather to train the man to think.

Other things being equal, the man who has had to work during his college course, on vacations, and possibly a year or two before going to college, has a better training than the man who has not done this. Working to earn one's own way develops a sense of responsibility and provides a training in dealing with people that is a most valuable asset in all industrial work. A man who takes a leading part in the musical, social, literary, or athletic activities of college also obtains a training that stands him in good stead, although he cannot use this training directly.

It should not be thought that the qualities desirable in a man who intends to train himself for a factory management position are different from those required in other departments. On the contrary, many of the qualities required are common to all men who wish to be a success. He should have a pleasing personality, an analytical type of mind, good judgment, a sense of justice, a desire

to deal with people rather than facts and figures, an abundance of tact, and ability to understand human nature.

Organizing a Definite Course of Training in a Factory

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has a course for training men having a college education for factory management positions. The aims of the course are to give the young man a broad general idea of the problems involved in running a factory and to make it possible for him to obtain some experience in dealing with men. He is given an opportunity to familiarize himself with the fundamentals of the various manufacturing departments, their functions, and their relations to each other. During the training period, the company officials also have an opportunity of becoming acquainted with the young man and of determining where he will best fit into the organization.

The length of the course is limited to about one year, because the average college graduate is seldom willing to give up more than this time to further systematized training. He is anxious to obtain a regular job.

The methods used in such a training course should be selected with a view to accomplishing the most good in the short period of a year. Whenever possible, the man should obtain his knowledge first-hand by actual performance. The course should be a combination of actual work in the various factory offices and some classroom work. In order that the student may obtain the shop point of view and know how it feels to actually do the work, he should be given a regular shop job for as long a time as can be spared out of the year, and should be treated exactly like every other workman on the floor.

Precautions to be Taken to Make the Course a Success

Care must be taken not to train more men than can be absorbed by the organization every year. In other words, there should be a real need for all the men trained, so that the opportunities ahead of them are attractive. The classroom group, for best results, should contain ten or twelve men.

Care should be taken to place the students in departments where the men in charge appreciate the aims of the plan and are willing to cooperate in training the men. Departments should be selected that will give the most satisfactory training in the shortest time. The students should not be offered a regular position until they have finished the year's training.

In order to obtain as broad and general a training as possible, the man should remain only a short time in one department. It must be constantly borne in mind that this man has to be treated as a student, and should be taught the system and principles involved by actually doing the work. As soon as he understands the work and begins to become of value in the department, it is evident that he should be given other work to do.

The Classroom Training—General Policies

The men should meet twice a week to study the general principles and fundamentals underlying factory management, and should be shown how these are applied in their everyday work. Whenever possible, the classes should be conducted by the discussion method and not by lectures. After the students have read and studied a given subject and discussed it, it is well to have a man in the factory organization who is an authority on the subject meet with the men and give them his experiences, following this with an informal discussion. However, the men themselves should conduct the course as far as possible.

It must be recognized as a general policy that the training of these men is a long-time investment, and returns should not be expected for several years. The men will not prove of much immediate value and in some cases they may be an actual hindrance during their training period, because they will (and should) ask many questions, and must constantly be shown how to do new work. For this reason, the department in which the man is working as a student should not be charged with this man's time. His wages should be charged to the general overhead, or to education, if a special account is kept for this purpose.

After the man has completed a year's course, he should be placed in the department which he prefers and for which he seems best fitted, then becoming a regular employe. Each man starts at the same salary, when he finishes the course. His work should be followed for three or four years, and he should be transferred whenever it seems advisable in order to give him as broad an experience as possible.

When a procedure of this kind is followed, a concern that has adopted it will find that after a few years, there is available a source of supply of men who have a broad enough foundation to enable them to be of real value to the organization and who are capable of further growth.

How the Westinghouse Company Obtains Men to be Trained

The educational department of the Westinghouse Electric & Mfg. Co. makes a canvass of the various engineering colleges in the early spring to select men for the graduate student course. The men who are finally accepted are interviewed by the educational department after they have worked in the plant a few weeks, and are asked whether they prefer sales, engineering, or factory management work. Those who prefer and seem suited for factory management are referred to a member of the works department, who talks with them and makes his selections. The men are accepted during July, August, and September.

Usually ten or twelve men are accepted each year and, as mentioned before, are required to work in the factory on a regular shop job for the first two months. This work may be of any kind—armature winding, assembling, or bench work. At the end of the two months, the student is placed in a shop office, the year being usually divided up somewhat as follows: Work as regular factory employe, two months; production department office in an assembly or feeder section, three months; manufacturing engineering office, one month; factory cost office, two months; time study and rate

setting department, three months; and miscellaneous work, one month.

The work in the production department includes storekeeping, order systems, schedules, general planning methods, and shipping. The work in the cost department covers such items as labor and material costs, timekeeping, payrolls, estimating, expense control and distribution, work-in-progress accounts, monthly comparative statements, overhead expense, and machine-hour rates. The time study and rate setting department provides experience in making time and motion studies, wage payment plans, routing work, and study of quantity manufacture from sales, engineering, and manufacturing points of view. The miscellaneous work includes such things as employment and personnel work, maintenance, plant lay-out, inspection, purchasing, and sales.

Outline of Class Work

The men are called together for their first class meeting early in the fall. The matter is "put up to them," and they make their own plans as to the nature of the work to be undertaken and the methods of conducting the class. One-hour meetings are held twice weekly. Kimball's "Industrial Organization" has been used as a text, with a different member of the class in charge of the discussion at each meeting.

Following are some of the main subjects considered in the classes; each is subdivided for more detailed study, and some are given more consideration than others: History of industry; industrial changes and tendencies; industrial ownership; principles of organization and administration; production control; compensation of labor; storekeeping; standards; costs; personnel administration; development of men; economics; and factory management.

The students have access to a comprehensive library on works management, so that opportunity is afforded for complementary reading. Departmental heads give talks on the functions of their departments so as to show the practical application of the theories taught. Opportunity is afforded for questions and discussions.

The men taking this course have come from practically every state in the union. They range in age from twenty to thirty years, the average age being about twenty-four years. The key note to the year's course in works management may be said to be an opportunity for each man to so develop himself as to be of greater service to the works manager's department of the company.

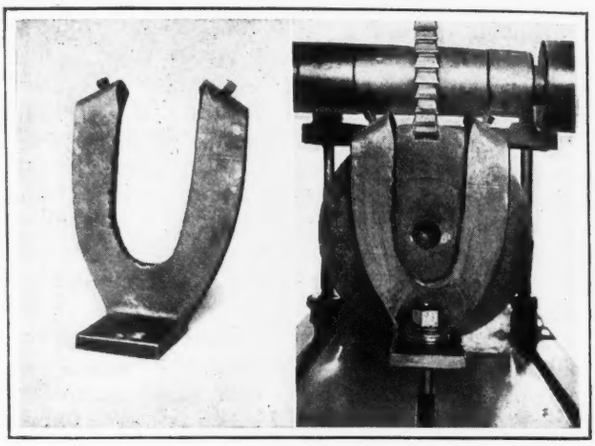
* * *

The National Association of Purchasing Agents has appointed a committee of seven men to investigate the subject of salesmen's calls—their waiting time and cost of interviewing them. The committee is now gathering statistics that will be used in an effort to solve the problem. Thus far, the figures accumulated indicate that 25 per cent of salesmen's calls are made where there is no opportunity for business; purchasing departments receive an average of thirty salesmen per day; and salesmen have an average wait of 7.8 minutes per call.

END CLAMP FOR CYLINDRICAL PARTS

By J. R. PHELPS, San Bernardino Shops, Atchison, Topeka & Santa Fe Railway, San Bernardino, Cal.

The end clamp here illustrated is intended especially for holding axles, crankpins, or other cylindrical parts while milling keyways. The clamp is divided, there being two holding arms so that the keyway can be milled to the end of an axle or other



End Clamp and Method of Applying it to End of Axle while Milling Keyseat

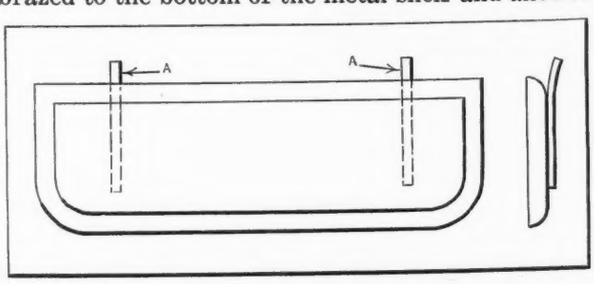
part without interference between the cutter and the clamp. The downward pull is obtained from a bolt engaging a T-slot in the machine table. This clamp is made of 5/8-inch boiler steel, and the design was suggested by J. S. Ladd, machinist at the San Bernardino Shops.

* * *

TAILSTOCK SHELF FOR TOOLMAKER'S LATHE

By WILLIAM S. ROWELL

A small shelf for scales, calipers, micrometers, etc., is a great convenience when attached to a machine tool in a suitable position. A shallow tray or shelf, 3 inches by 12 inches by 3/8 inch deep, of the design shown in the accompanying illustration, which was attached to the front side of the tailstock of a toolmaker's lathe, proved very useful. Two pieces of 3/16-inch cold-rolled steel *A* were brazed to the bottom of the metal shelf and allowed



Tailstock Shelf for Toolmaker's Lathe

to project about 1/2 inch on one side. These projecting ends were bent down slightly, as shown in the end view. Holes were drilled in the side of the tailstock to receive the pins *A*. These holes were, of course, drilled at an angle which brought the shelf level. The object in bending the ends of the pieces *A* was to prevent the shelf from sliding out of place and yet permit it to be easily removed by slightly raising the outer edge.

Design of Relieved Clutch Teeth

By FRED ADAMS

RELIEVED clutch teeth of the design shown in Fig. 1, for driving in one direction, have several decided advantages over the square-tooth type shown at *A*, Fig. 2, and the inclined-tooth type shown at *B*. They enter more easily into engagement and, in fact, can be engaged at higher speeds than the designs shown at *A* and *B*. The clutch teeth shown in Fig. 1 are so formed that the force of the blow is exerted in the center of the back of the teeth. More clearance may be allowed between these teeth without sacrificing strength, the base of the tooth being just as strong as that of the other two types mentioned. They disengage easily, and one cut with a gang of two milling cutters placed back to back completes the forming of a tooth. The teeth in either right- or left-hand clutches can be cut with one pair of milling cutters when necessary.

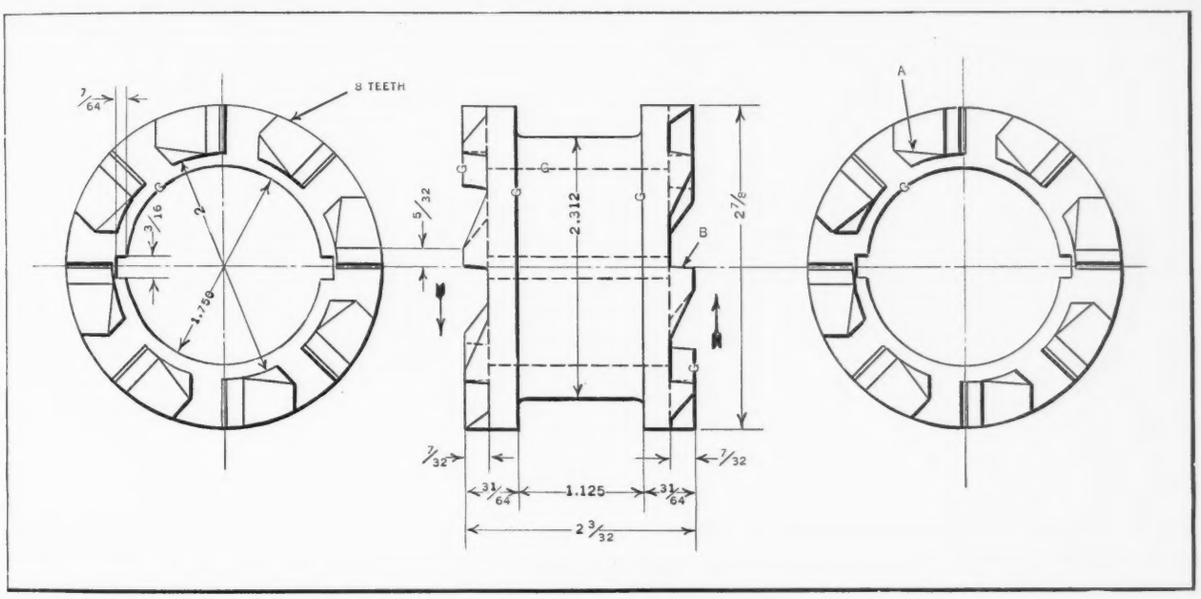


Fig. 1. Relieved Clutch Teeth

The contact or driving face has the same angle as the inclined type, namely 6 degrees, which has been found by experience to meet the driving and releasing requirements satisfactorily. The point of contact is along line *A*, Fig. 1, approximately in the center of the tooth. This means that the backs of the opposing teeth will make contact first and ride down the incline until face *B* comes in contact with the teeth of the other clutch member. With this arrangement, the sudden drop into engagement and the clatter noticeable in the other types is eliminated.

The clutch shown in Fig. 5 was examined after six months of very severe service in which it was used to reverse a table weighing 900 pounds one-hundred times a minute. As the clutches were blackened in the heat-treating process, the actual amount of wear could be easily noted. As a matter of fact, the blackened surface showed practically no wear. These clutches were run in an oil splash bath. The crest on the back of the tooth, formed by the two angular cuts along line *A*, Fig. 1, were "touched off" with a file before heat-treating. This served to relieve point contact where the teeth start to mesh.

For speedy engagement and quick pick-up, a greater number of teeth may be employed than in the case of the clutch shown in Fig. 1. For instance, the clutch shown at *F*, Fig. 2, is of the same size, but has twenty-two teeth. In this case, the angles are steeper and the land at the top of the tooth and the clearance are smaller. Cutters of the type shown at *G* are used in cutting the teeth of this clutch.

Clutch Material and its Heat-treatment

Any alloy gear steel that is properly heat-treated and that retains its shape and size well will be satisfactory for clutches. Clutches of the type described have been made of cold-rolled steel and S. A. E. 1015 steel, which has a low carbon content. The grain of both the core and outer surfaces must be refined by the "three heat-treatment" method, namely, carburize, reheat, and harden in oil; reheat and harden in water; then draw in oil at a temperature of 450 degrees F.

As previously mentioned, one pair of cutters will serve to cut both right- and left-hand clutches. This is accomplished by feeding the cutters from the center outward when cutting the teeth in one clutch, and starting the feed at the outer edge and feeding inward in the other clutch. From the

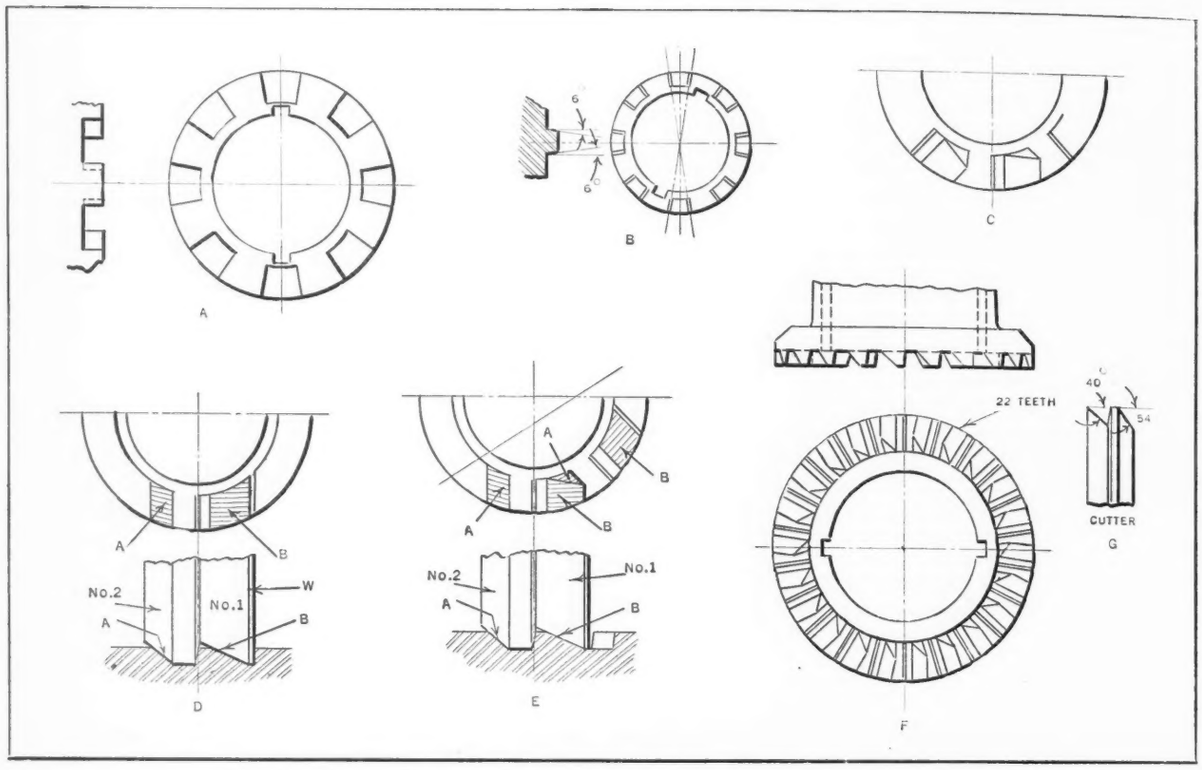


Fig. 2. Various Types of Clutch Teeth and Cutters for Milling Clutch Teeth

standpoint of efficient machining, the first method is preferable, because the arbor supports the work better nearer the center of the clutch where the heaviest part of the cut is taken. Also the burrs caused by the cutter will be on the outer surface where they can be more readily removed. To cut the teeth of both clutch members in this manner, it is necessary to have two sets of cutters, one for right-hand and the other for left-hand teeth.

At *D*, Fig. 2, is shown diagrammatically how the first cut is taken in the blank. The manner in which the second cut is taken is shown at *E*. The angular surfaces machined in these operations are indicated by the same reference letters in both views. The complete tooth is shown in the view at *C*. Referring to view *D*, cutters No. 1 and No. 2 are mounted together on the same shaft. On the first pass of these cutters, the surfaces *A* and *B* are

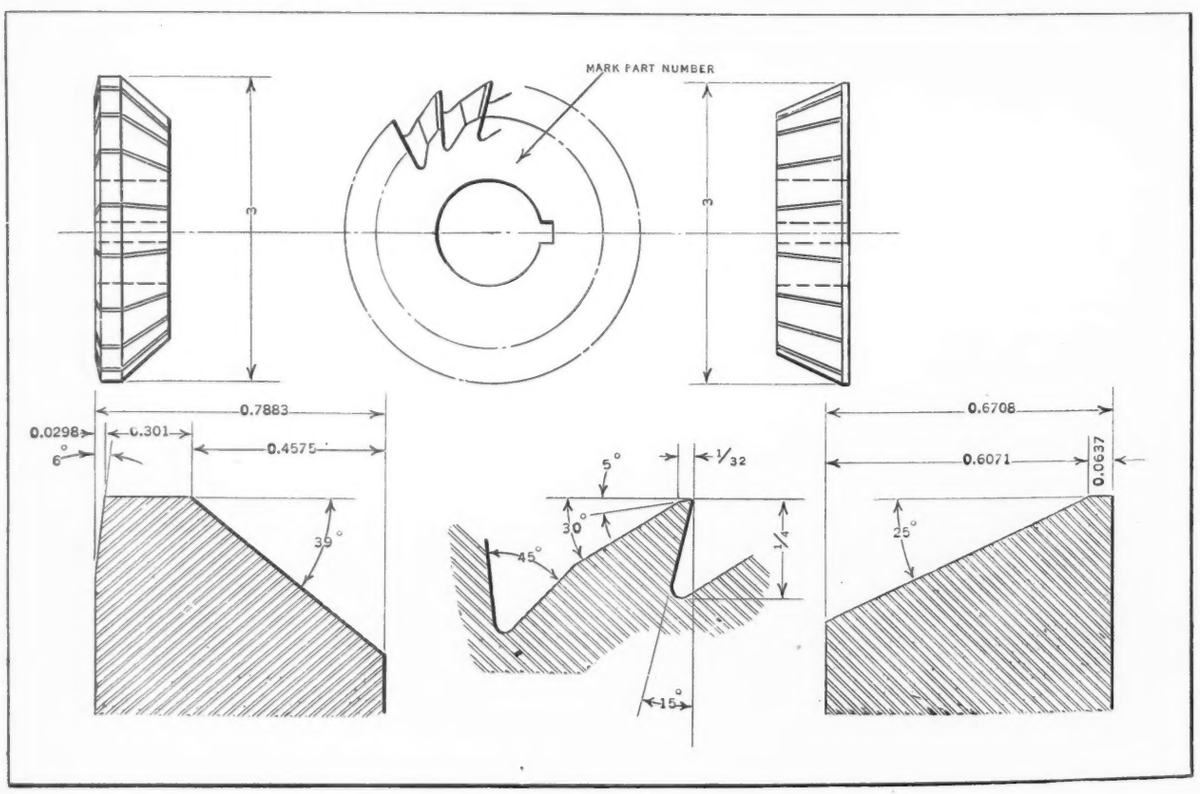


Fig. 3. Details of Clutch Tooth Milling Cutters

machined. In the second operation, the work is indexed around one tooth space so that on the second pass of the cutters, the surface *A* at the extreme left is milled by cutter No. 2, and the surface *B* just to the right of the center line is milled by cutter No. 1, thus completely forming one tooth. The various factors involved in the design of clutch teeth of the type described are referred to in the following, in the order in which they would ordinarily be considered.

1. The outside diameter of the clutch, which is determined by the conditions and service for which the clutch is to be used.

All other dimensions are calculated from these dimensions and are given as they are determined, step by step, in the following tabulations. It is well to make the scale of the lay-out drawing several times the actual size. This is a great help in developing the tooth and cutter details. The large-scale drawing also serves to check the calculations and approximately determine the angles.

Calculations Required in Designing Clutch Teeth and Milling Cutter

Let it be assumed that there are eight teeth in the clutch to be designed. Consequently angle *B*,

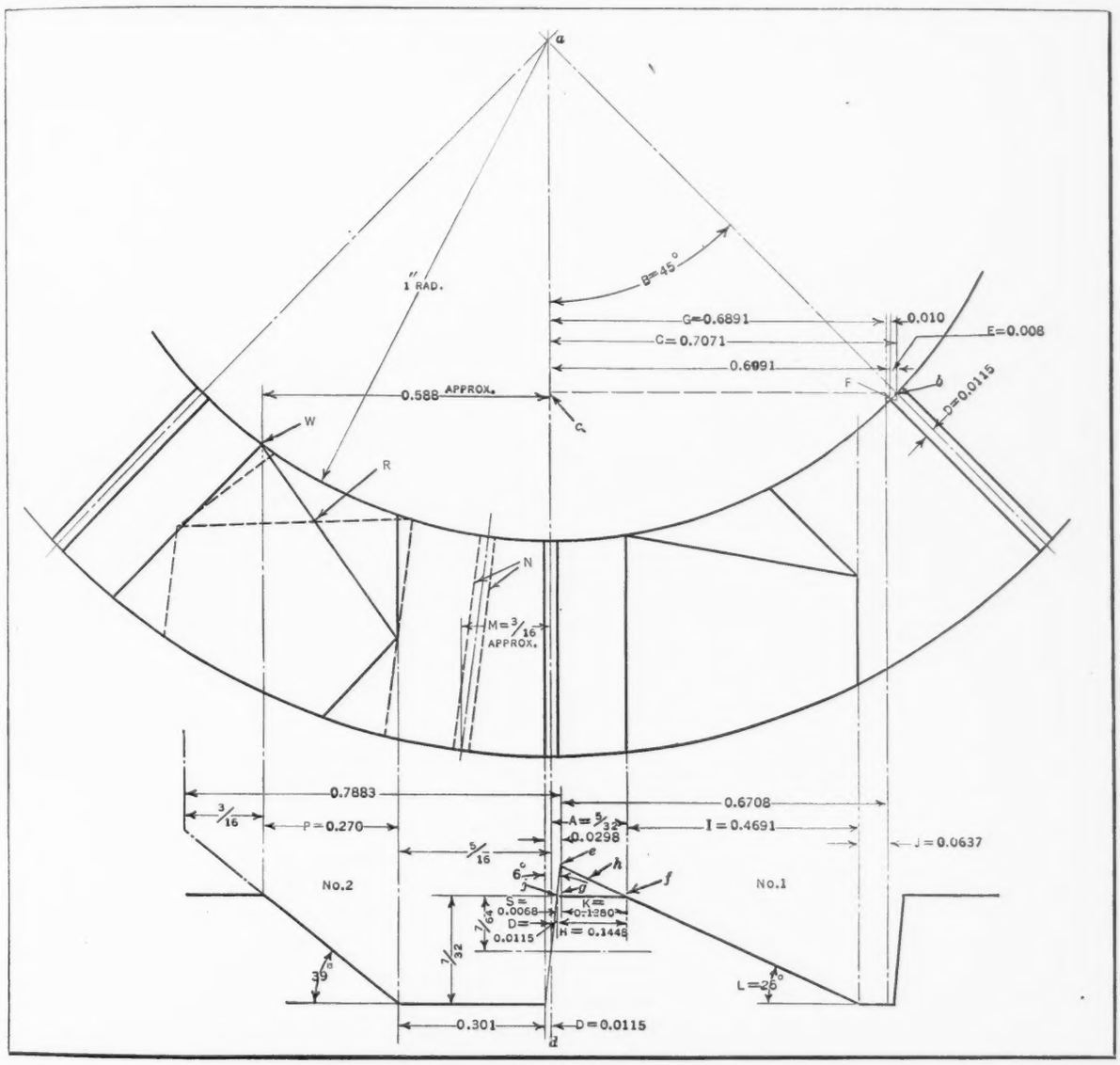


Fig. 4. Diagram Used in Designing Clutch Teeth and Milling Cutters

2. The number of teeth in the clutch, which is governed by the rapidity of "pick-up" required.

3. The width and depth of the tooth. Making the depth of the tooth equal one-half the width has been found very satisfactory.

4. Assume an approximate width of land *A*, Fig. 4, for the top of the tooth. This dimension extends to the center line of the driving face. The actual width of the land should be calculated subsequently.

The driving angle should be 6 degrees in all cases. In the example to be considered, the dimensions that must be assumed are shown in Fig. 4. Fig. 4, will equal 360 divided by 8, or 45 degrees. Referring to Fig. 4, we have in the triangle *abc* the hypotenuse *ab* equal to 1 inch and the side adjacent equal to 0.7071 inch. Therefore dimension *C*, from the center of line *ad* to the center of the 6-degree face, is 0.7071 inch. Now, by solving the small triangle at *F* by trigonometry, dimension *D* is found to be 0.0115 inch. The side *E* of this small triangle is 0.008 inch. Subtracting *E* from *C* gives us the dimension 0.6991 inch. As the cutter must clear the tooth at point *B*, Fig. 5, by about 0.010 inch, we have dimension *G*, Fig. 4, equal to 0.6991 minus 0.010 inch equals 0.6891 inch.

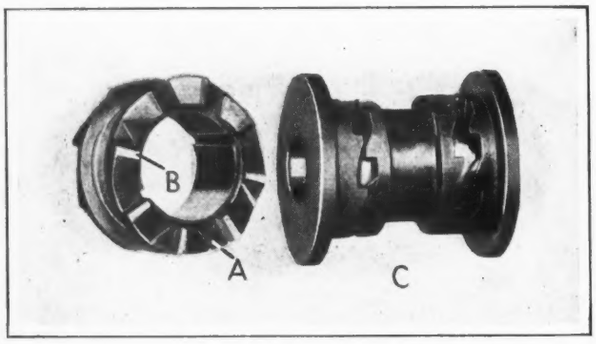


Fig. 5. Clutch of Relieved Tooth Type

By trial, we find that an angle L of 25 degrees will allow a small flat on the periphery of cutter No. 1, as shown at W, Fig. 2. A flat at this point is more desirable than a sharp edge, as it will not become dull so quickly. At A, Fig. 5, will be seen a slight groove running diagonally across the tooth space. This groove is left by the cutter and shows that the edge cleared point B and gave practically a full tooth contact. The actual width H of the land on the top of the tooth is 0.1448 inch, as indicated in Fig. 4. The side I of the 25-degree triangle is now computed, and found to be 0.4691 inch. Adding 5/32 inch to 0.4691 we obtain the dimension 0.6254 inch, which, subtracted from dimension G, gives us 0.0637 inch, which is the width of the flat J.

In order to complete the design of cutter No. 1, we must find the length of side K in triangle efg. Using the formula for oblique triangles, we have

$$\text{side } h \text{ equals } \frac{0.1448 \times \sin 84 \text{ degrees}}{\sin 71 \text{ degrees}}.$$

Now by trigonometry, side K is found to be 0.1380 inch, and this added to dimensions I and J will give the total width of cutter No. 1, or 0.6708 inch. The shape of the cutter tooth is shown in Fig. 3.

The next problem is to determine the proper clearance to be allowed at the front of the driving face of the clutch teeth, or in other words, the maximum space between the driving surfaces after the clutch members have been forced together but not rotated to bring them into driving contact. Referring to Fig. 4, this clearance is indicated by the approximate dimension M. The dotted lines at N represent the 5/32-inch land of the meshing teeth when the clutch is fully meshed but before the driving member has advanced to make contact with the teeth of the driven member. The approximate trial dimension M may be determined graphically. Let us assume that the width of the bottom of the tooth space from the center line is 5/16 inch. The exact width, as determined later by actual calculation, was found to be 0.301 inch. The assumed dimension, 5/16 inch, serves as the starting point of the angular surface on cutter No. 2.

The line formed by the intersection of the angular surfaces milled by cutters Nos. 1 and 2 passes approximately through point W, Fig. 4. The location of this point or line of intersection may either be calculated or found graphically, the latter method being the easier to apply and just as satisfactory. The length of the side P of the triangle involved in calculating the position of this line is 0.270 inch. From 1/8 to 3/16 inch is added to this side to insure a perfect tooth. The opposing teeth hit at R and slide along the ridges into full engagement. (See view C, Fig. 5).

Completing the calculations of the oblique triangle efj, we find dimension S to be 0.0068 inch. Adding 3/16, dimension P, 0.301, and 0.0298 we obtain the total width of cutter No. 2, which is 0.7883 inch. The details of the cutter tooth and the dimensions that have been found satisfactory for cutting the clutch teeth are shown in Fig. 3.

* * *

TAPER ADAPTER FOR MILLING CUTTERS

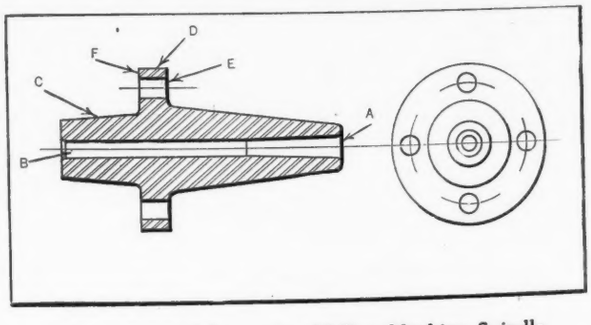
By R. A. DRESSLER

It is often desirable, or necessary, to use a small taper-shank tool, such as an end-mill, in the spindle nose of a large milling machine. When standard collets are employed in the usual manner to adapt these tools for such work, considerable trouble is experienced in aligning the tools and preventing them from working loose.

At times it is necessary to use two or more collets, one placed within the other, in order to hold a small tool in a large spindle. In some cases, the short shanks on the small tools make it impossible to use them at all, as they will not reach the work when the table is in the extreme rear position.

In one plant, adapters like the one shown in the accompanying illustration, were made up, in order to eliminate the excessive breakage of small tools used in the manner described. Adapters of this kind can be designed to carry the tool out over the table any reasonable distance and still support the tool very rigidly, a factor that is essential if the best results are to be obtained with small end-mills. No dimensions are given in the illustration, as they are necessarily determined by individual requirements. The particular adapter shown, however, was made to fit the spindle of a No. 1 1/2 milling machine and to hold tools having No. 1 Morse taper shanks.

The end A is reamed to fit the taper of the small tool, while the clearance hole in the end B is made straight to accommodate the knock-out rod. The end C is machined to fit the Brown & Sharpe taper in the spindle nose of the milling machine, and should be a snug fit when the flange D is drawn up to the flange on the nose of the spindle. Holes are provided at E to receive cap-screws for clamping the flange to the spindle. Care should be taken to see that the stub shank C is machined concentric with taper hole A and that rear surface F of the flange is square with the center line of the holder.



Taper-shank Adapter for Milling Machine Spindle

Multiple Spot-welding

Making Six Welds Simultaneously by the Point or Projection Method

WHEN the installation of a new machine results both in materially increased production and in higher quality work, the investment is doubly fortunate. Both of these aims have been attained by the John Warren Watson Co., of Philadelphia, Pa., through the recent installation of a spot-welding machine. This machine is employed for welding a sheet-steel cover to the sheet-steel cover drum of automobile "Stabilators."

Fig. 1. Making Six Welds Simultaneously 700 Times Per Hour

Formerly, the operation was performed on foot-operated machines, and eighteen welds were often necessary to hold the two parts together, because the pressure on the parts during the welding varied in successive operations due to the human element involved. The production averaged 110 welded units per hour.

With the new equipment, only six welds are required, as the conditions under which the operation is performed are always constant. Moreover, 700 welded units are averaged per hour. The machine is a standard Thomson heavy-duty welder having a rating of 175 kilovolt-amperes. It is equipped with special electrodes by means of which the six welds are produced at one time on the parts. There is also a special indexing table, which permits the operation to be performed on a semi-automatic basis. The only work required of the operator and his helper consists of loading and unloading the indexing table.

Details of the Operation

The cover drum is drawn from cold-rolled steel of a minimum thickness of 0.059 inch and a maximum thickness of 0.063 inch, while the cover is drawn from steel having thickness limits of 0.035 and 0.042 inch. Six equally spaced points or projections *A*, Fig. 3, are punched around the top of the drum to facilitate the operation. These points must not be more than 0.045 inch high or less than 0.035 inch. After the welding operation, the space between the top of the drum and the inside of the cover, which is obtained by means of these projections, must be uniform within 0.005 inch. When the two parts are in place for welding, the only contact between them occurs at the six projections *A*. Each projection is located directly over a tip of a lower electrode unit and directly beneath a tip of an upper electrode unit actuated by the ram of the machine.

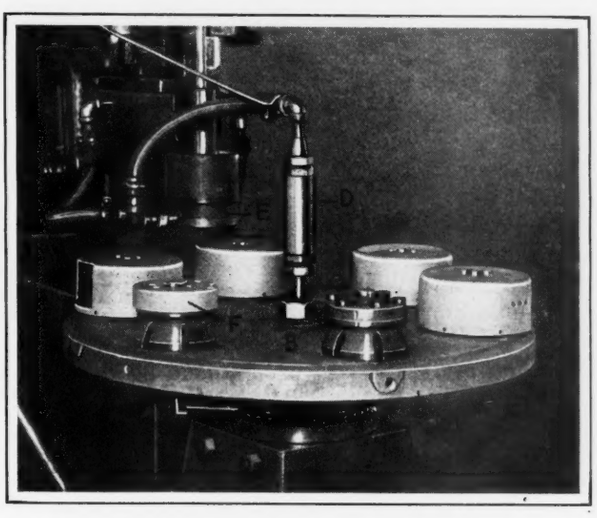


Fig. 2. Close-up View of the Table Unit and the Upper Electrode

Six lower electrode units *B*, Fig. 2, are spaced around an indexing table *C*. Each of these electrodes consists of a copper casting on which are brazed six small tips made of "Elkonite." These tips come in contact with the inside of the drum, while "Elkonite" tips on the upper electrode *E* mounted on the machine ram come in contact with the cover.

"Elkonite" is an alloy of copper and tungsten, and was chosen as the material from which to make the welding tips, because it was found that copper tips became indented so quickly that they had to be resurfaced after welding only about fifty parts. This indentation was due to the pressure of 1500 pounds on the hot electrodes in the operation. With "Elkonite" tips, 6000 parts can be welded before the tips require resurfacing. Water is supplied to the electrode units of the table through connection *D* and holes bored in the table. Electrode *E* on the ram of the machine is also water-cooled. (The characteristics of "Elkonite" were fully described in April, 1926, MACHINERY, page 667.)

In the operation of the machine, the table rotates intermittently, carrying each lower electrode, with the two parts on it, beneath the ram of the machine. Here the table stops and the ram lowers electrode *E* on the work, maintaining contact for about one second. The ram then raises electrode *E*, and the finished work indexes from beneath it, while the unwelded work is carried into place. As the table carries the welded parts toward the right-hand side of the machine, the operator removes the finished work and slips a drum in place, as shown at *F*. His helper places a cover over the drum as the table moves past him. Proper location of both the drum and cover is insured by seating two slots in these parts over the keys of a mandrel which extends from the center of each table electrode. The diameter of the spot welds averages about 1/4 inch.

Current for the welding is supplied at the proper time and for the desired length of time by a magnetic circuit-breaker which is opened and closed through a cam-operated contactor. Adjustments provide for regulating the welding pressure, the current value, and the duration of the current, as

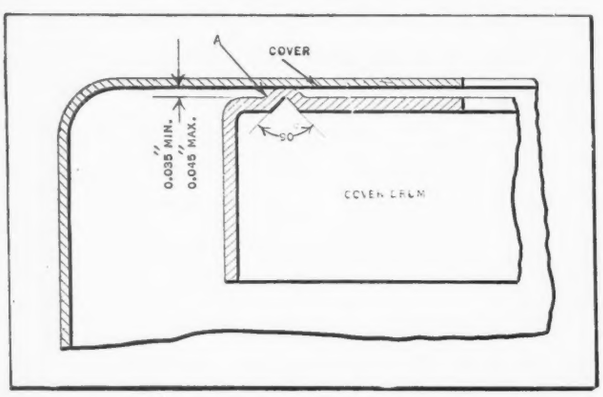


Fig. 3. Diagram Illustrating the Relation Between the Welded Parts

well as its location in the welding cycle. These adjustments permit proper coordination of the various steps in the operation. There is also means of adjusting the electrodes to compensate for changes in height as a result of resurfacing the "Elkonite" tips.

How the Table is Indexed

Twelve indexings of the table are made per minute and this, of course, corresponds to the number of ram strokes per minute. Power for indexing the table is delivered from the camshaft of the machine through spur gear *G*, Fig. 1, and then through a second spur gear and bevel gears to universal shaft *H*. The universal shaft transmits the drive to a Geneva movement, the driven member of which has six slots and is mounted on the table shaft at *J*. A braking mechanism at *K* stops the table each time the driving member of the Geneva mechanism leaves a slot of the driven member, and thus accurately positions each table electrode successively under the electrode mounted on the ram of the machine. Friction in indexing the table has been substantially reduced by the use of a large ball bearing *L*, Fig. 2. A motor of three-horsepower capacity drives the welder.

CLEARANCE HOLES FOR SCREWS

By J. K. OLSEN, Chief Draftsman,
Stewart-Warner Speedometer Corporation, Chicago, Ill.

To provide an easy assembly of parts and insure that screws will enter readily, a certain amount of clearance is allowed between the body of a screw and the hole in whatever part the screw holds. The accompanying table gives the clearance hole sizes for machine screws from No. 0 to 1/4 inch, and it covers both the drilled and punched clearance holes, as well as holes in metal and fiber. It will be noted

Clearance Hole Sizes for Machine Screws

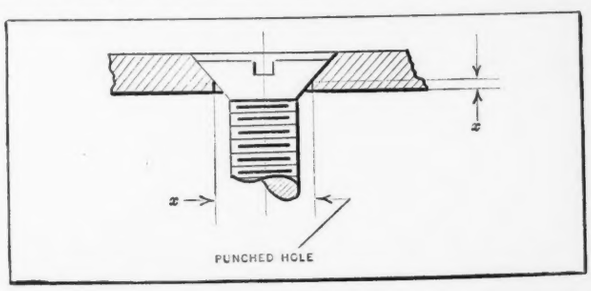
Screw Number	Screw Diam., Inch	Metal			Fiber		
		Drill Number	Drill Size, Inch	Punch Size, Inch	Drill Number	Drill Size, Inch	Punch Size, Inch
0	0.060	51	0.067	0.069	50	0.070	0.069
1	0.073	46	0.081	0.085	44	0.086	0.085
2	0.086	41	0.096	0.099	39	0.0995	0.099
3	0.099	..	7/64	0.112	33	0.113	0.112
4	0.112	..	1/8	0.127	30	0.1285	0.127
5	0.125	..	9/64	0.143	27	0.144	0.143
6	0.138	24	0.152	5/32		5/32	5/32
8	0.164	15	0.180	0.185	13	0.185	0.185
10	0.190	4	0.209	0.212	3	0.213	0.212
12	0.216	"B"	0.238	0.242	"C"	0.242	0.242
1/4	0.250	"J"	0.277	9/32		9/32	9/32

Machinery

that the drilled holes in fiber are slightly larger than those in metal. This is because of the tendency of fiber to contract after the drill is removed, the size of the hole being approximately 0.003 inch smaller than the drill size.

For screw sizes from 1/4 to 5/8 inch, inclusive, the general rule is to use a clearance drill approximately 1/32 inch larger than the screw; for sizes of 3/4 inch and larger, the clearance may be 1/16 inch, provided ordinary bolts are to be used and close work is not required.

The clearance hole for a flat-head screw, when the stock thickness is less than the depth of the screw head, is shown by the accompanying illustration. The screw head, as a rule, is either flush or slightly lower than the stock surface, and the



Clearance Hole when Stock Thickness is Less than Depth of Flat-head Screw

clearance hole should be large enough to provide a cylindrical part x at the bottom equal to about one-tenth of the stock thickness. If the stock thickness exceeds the height of the screw head, regular clearance holes are used.

* * *

A motor so small that its rotor could be wrapped in a postage stamp is used by the Westinghouse Electric & Mfg. Co. for timing the OB watthour meter demand register.

MACHINERY'S DATA SHEETS 115 and 116

TAP DRILL TABLE

Tap No. or Diameter	Threads per Inch	Material to be Tapped						
		Hard Rubber, Fiber, Thin Brass	Brass	Cast Iron	Steel	Copper	Clearance Easy	Clearance Tight
2	56	50	49	48	47	46	42	41
3	48	46	45	44	42	42	37	36
4	36	48	42	41	40	39	31	30
6	32	33	32	31	30	29	27	26
8	32	29	28	27	26	25	18	17
10	24	22	20	19	18	17	9	8
10	24	24	23	22	20	19	9	8
12	24	16	15	14	13	13	1	15/64
14	20	9	7	6	5	4	1/4	17/64
14	20	10	8	7	6	5	1/4	17/64
1/4	20	8	6	5	4	3	17/64	9/32
18	18	3	2	2	1	1	19/64	5/16
18	20	2	1	1	15/64	15/64	19/64	5/16
5/16	18	1	15/64	15/64	1/4	1/4	5/16	21/64
20	18	15/64	1/4	1/4	17/64	17/64	21/64	11/32
3/8	16	9/32	19/64	5/16	21/64	21/64	3/8	25/64
7/16	14	5/16	11/32	23/64	3/8	3/8	7/16	29/64
1/2	13	25/64	13/32	27/64	7/16	7/16	1/2	33/64
1/2	12	3/8	25/64	13/32	27/64	27/64	1/2	33/64
9/16	12	7/16	29/64	15/32	31/64	1/2	9/16	37/64
5/8	11	31/64	1/2	33/64	17/32	35/64	5/8	41/64
3/4	10	39/64	5/8	41/64	21/32	43/64	3/4	49/64
7/8	9	23/32	47/64	3/4	49/64	25/32	7/8	57/64
1	8	13/16	27/32	55/64	7/8	57/64	1	11/32
1 1/8	7	15/16	31/32	31/32	1	1 1/64	1 1/8	1 5/32
1 1/4	7	1 1/16	1 3/32	1 7/64	1 1/8	1 9/64	1 1/4	1 9/32
1 3/8	6	1 3/16	1 7/32	1 15/64	1 1/4	1 17/64	1 3/8	1 13/32
1 1/2	6	1 5/16	1 11/32	1 23/64	1 3/8	1 25/64	1 1/2	1 17/32
1 5/8	5 1/2	1 13/32	1 27/64	1 7/16	1 29/64	1 15/32	1 5/8	1 21/32
1 3/4	5	1 7/16	1 15/32	1 35/64	1 9/16	1 37/64	1 3/4	1 25/32
1 7/8	5	1 1/2	1 17/32	1 43/64	1 11/16	1 45/64	1 7/8	1 29/32
2	4 1/2	1 5/8	1 21/32	1 25/32	1 51/64	1 13/16	2	2 1/16

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MACHINERY'S Data Sheet No. 115, New Series, October, 1927 — Contributed by C. L. Ganster

PERCENTAGES OF ELONGATION AND REDUCTION IN AREA

Standard Test Specimens

Elongation of Test Specimen						Reduction in Area					
Length after Fracture, Inches	Percentage of Elongation	Length after Fracture, Inches	Percentage of Elongation	Length after Fracture, Inches	Percentage of Elongation	Diameter after Fracture, Inch	Percentage of Reduction	Diameter after Fracture, Inch	Percentage of Reduction	Diameter after Fracture, Inch	Percentage of Reduction
2 1/64	0.781	2 33/64	25.781	3 1/64	50.781	0.505	0.0	0.335	56.0	0.165	89.5
2 1/32	1.563	2 17/32	26.563	3 1/32	51.563	0.500	2.0	0.330	57.0	0.160	90.0
2 3/64	2.344	2 35/64	27.344	3 3/64	52.344	0.495	4.0	0.325	58.5	0.155	90.5
2 1/16	3.125	2 9/16	28.125	3 1/16	53.125	0.490	5.5	0.320	60.0	0.150	91.0
2 5/64	3.906	2 37/64	28.906	3 5/64	53.906	0.485	7.5	0.315	61.0	0.145	91.5
2 3/32	4.688	2 19/32	29.688	3 3/32	54.688	0.480	9.5	0.310	62.0	0.140	92.5
2 7/64	5.469	2 39/64	30.469	3 7/64	55.469	0.475	11.5	0.305	63.5	0.135	93.0
2 1/8	6.250	2 5/8	31.250	3 1/8	56.250	0.470	13.0	0.300	64.5	0.130	93.5
2 9/64	7.031	2 41/64	32.031	3 9/64	57.031	0.465	15.0	0.295	66.0	0.125	94.0
2 5/32	7.812	2 21/32	32.813	3 5/32	57.812	0.460	17.0	0.290	67.0	0.120	94.5
2 11/64	8.594	2 43/64	33.594	3 11/64	58.594	0.455	18.5	0.285	68.0	0.115	95.0
2 3/16	9.375	2 11/16	34.375	3 3/16	59.375	0.450	20.5	0.280	69.0	0.110	95.25
2 13/64	10.156	2 45/64	35.156	3 13/64	60.156	0.445	22.0	0.275	70.5	0.105	95.65
2 7/32	10.938	2 23/32	35.938	3 7/32	60.938	0.440	24.0	0.270	71.0	0.100	96.05
2 15/64	11.719	2 47/64	36.719	3 15/64	61.719	0.435	25.5	0.265	72.5	0.095	96.45
2 1/4	12.500	2 3/4	37.500	3 1/4	62.500	0.430	27.5	0.260	73.5	0.090	96.8
2 17/64	13.281	2 49/64	38.281	3 17/64	63.281	0.425	29.0	0.255	74.5	0.085	97.1
2 9/32	14.063	2 25/32	39.063	3 9/32	64.063	0.420	30.5	0.250	75.5	0.080	97.5
2 19/64	14.844	2 51/64	39.844	3 19/64	64.844	0.415	32.5	0.245	76.5	0.075	97.8
2 5/16	15.625	2 13/16	40.625	3 5/16	65.625	0.410	34.0	0.240	77.5	0.070	98.05
2 21/64	16.406	2 53/64	41.406	3 21/64	66.406	0.405	35.5	0.235	78.5	0.065	98.35
2 11/32	17.187	2 27/32	42.188	3 11/32	67.187	0.400	37.0	0.230	79.0	0.060	98.6
2 23/64	17.969	2 55/64	42.969	3 23/64	67.969	0.395	38.5	0.225	80.0	0.055	98.8
2 3/8	18.750	2 7/8	43.750	3 3/8	68.750	0.390	40.0	0.220	81.0	0.050	99.0
2 25/64	19.531	2 57/64	44.531	3 25/64	69.531	0.385	42.0	0.215	82.0	0.045	99.2
2 13/32	20.313	2 29/32	45.313	3 13/32	70.313	0.380	43.5	0.210	82.5	0.040	99.35
2 27/64	21.094	2 59/64	46.094	3 27/64	71.094	0.375	44.5	0.205	83.5	0.035	99.5
2 7/16	21.875	2 15/16	46.875	3 7/16	71.875	0.370	46.0	0.200	84.5	0.030	99.65
2 29/64	22.656	2 61/64	47.656	3 29/64	72.656	0.365	47.5	0.195	85.0	0.025	99.75
2 15/32	23.438	2 31/32	48.438	3 15/32	73.438	0.360	49.0	0.190	86.0	0.020	99.85
2 31/64	24.219	2 63/64	49.219	3 31/64	74.219	0.355	51.0	0.185	86.5	0.015	99.9
2 1/2	25.000	3	50.000	3 1/2	75.000	0.350	52.0	0.180	87.5	0.010	99.96
						0.345	53.0	0.175	88.0	0.005	99.99
						0.340	55.0	0.170	88.5		

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MACHINERY'S Data Sheet No. 116, New Series, October, 1927 — Contributed by Walter W. Mohr

Conventions and Meetings of the Month

IN conjunction with the three expositions of machine tools held during September—the National Machine Tool Builders' Exposition in Cleveland, the American Society for Steel Treating Exposition in Detroit, and the Machine Tool Exhibition in New Haven—numerous technical meetings were held at which papers covering a wide range of subjects were read and discussed. It is not possible in a brief space to review all the papers read or even to indicate all the subjects dealt with, but those interested in any particular phase of the industry can obtain full information in regard to the papers presented by addressing the secretaries of the different organizations. A list of the organizations with the addresses of their headquarters will be found at the end of this article.

The Machine Tool Congress in Cleveland

For some time it has been felt that there should be some kind of forum where users, builders, designers, and distributors of machine tools could freely discuss problems of common interest. Many men responsible for the design and building of machine tools and for the use of these machines in production are not members of engineering societies, and yet they not only could contribute much to discussions of this kind, but would also receive much benefit from them. An opportunity for bringing together men of this type was afforded at the National Machine Tool Builders' Exposition in Cleveland, September 19 to 23.

A congress, known as the Machine Tool Congress, was formed, the first meetings of which were held in conjunction with the machine tool session of the Society of Automotive Engineers at the Hotel Winton, Cleveland, Monday, September 19, and Tuesday, September 20. Other sessions of the congress were held on Wednesday and Thursday evenings at the Hotel Cleveland.

The program at these sessions dealt with problems of standardization as applied to machine tools and its advantages to users, designers, and builders of such equipment. The discussions covered the question of standardization, first, from the broad aspect of standardization in general and, second, from the point of view of its benefits to the machine shop industry. One of these discussions was led by Dr. P. G. Agnew, secretary of the American Engineering Standards Committee.

Another discussion was led by James E. Gleason, president of the National Machine Tool Builders' Association and president of the Gleason Works, Rochester, N. Y. He set forth the advantages of standardization from the machine tool builder's point of view. S. A. Einstein, chief engineer of the Cincinnati Milling Machine Co., Cincinnati, Ohio, discussed the question of standardization from the engineering point of view. Other speakers, well known in the mechanical engineering field, presented standardization of machine tools from the user's viewpoint.

The Society of Automotive Engineers held three sessions in Cleveland. At these sessions papers were read relating to both the manufacturing and the business side of production. A machine tool session dealt particularly with the application of electric motors to machine tools, and the application of abrasives to the finishing of internal and external surfaces.

The Technical Program at Detroit

In conjunction with the Ninth Annual National Steel and Machine Tool Exposition held in Detroit under the auspices of the American Society for Steel Treating during the same week as the National Machine Tool Builders' Exposition was held in Cleveland, technical sessions were arranged for by several national societies—the American Society for Steel Treating, the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, the Society of Automotive Engineers, and the American Welding Society.

A program of more than forty-five papers was presented before the American Society for Steel Treating, every branch of the steel and heat-treating field being dealt with. The automotive engineers discussed the relation of metallurgy to production, production engineering, fire hazards incident to the spraying of inflammable finishes, and time study. The Metals Division of the Institute of Mining and Metallurgical Engineers discussed non-ferrous metallurgy, and the American Welding Society dealt with airplane welding, welds subjected to high temperatures, automobile welding, production welding of water heaters, welding of structural steel, and the design of steel plate work for welding.

The New Haven Machine Shop Practice Meeting

Nine papers of great interest were presented at the sessions of the Machine Shop Practice Division of the American Society of Mechanical Engineers, which were held in conjunction with the New Haven Exposition on September 7, 8, and 9. These papers dealt with such important subjects as the economy derived from using up-to-date machine shop equipment; machine tool replacement policies of large manufacturing plants; recent materials for finishing machines; principles of polishing; training of foremen; improved equipment for copper wire mills; rotary swaging; and application of anti-friction bearings in machine tools and ordnance. All sessions were well attended, and worthwhile discussions followed the reading of papers.

Following is a list of the headquarters of the associations referred to: National Machine Tool Builders' Association, 630 Vine St., Cincinnati, Ohio. American Society for Steel Treating, 4600 Prospect Ave., Cleveland, Ohio. Society of Automotive Engineers, American Institute of Mining and Metallurgical Engineers, American Welding Society, and American Society of Mechanical Engineers, 29 W. 39th St., New York City.

Current Editorial Comment

in the Machine-building and Kindred Industries

THE GREAT EXPOSITIONS

The two largest expositions of machine tools, heat-treating equipment, small tools and shop accessories ever held have just closed their doors as MACHINERY goes to press. It would be futile to try to enumerate the hundreds of new machines, devices, and tools exhibited by the 494 exhibitors at these shows, and difficult to pick out even the outstanding new developments shown, because radically new tools were exhibited in almost every branch of the shop equipment industry.

No previous exhibition of machine tools and accessories has approached in size and character that just held in Cleveland. The numerous tools exhibited embodied, almost without exception, advances in design and construction of the greatest importance to the entire machine-manufacturing industry. At Detroit the great exhibition of heat-treating equipment, shop accessories and steels marked another notable advance in industrial progress. The American shop equipment industries made a supreme effort to show, at these expositions, the very best they could produce; and their efforts were not only successful, but well rewarded, because the attendance at both expositions was unusually large and the interest shown in the new products never lagged.

During the month another exposition, more of a local character, but filling a distinct need in the New England states, was held at New Haven, Conn., showing equipment of the highest quality. In addition, a Machine Shop Practice Meeting was held at New Haven simultaneously with the exhibit, at which papers of national interest and importance were presented.

These great exhibits of shop equipment are becoming more than expositions—they are educational institutions where shop executives responsible for production can learn more in a few days about recent developments in machine shop practice and the equipment and methods available than would otherwise be possible in weeks. No observing visitor could possibly come away from any of the expositions held during the month without a fund of knowledge that should help him to improve his own manufacturing facilities and methods, regardless of how well equipped his shop may be.

* * *

ELECTRIC MOTOR STANDARDIZATION

The need for interchangeability of electric motors for machine tools has been emphasized at several meetings of the National Machine Tool Builders' Association, and also has been discussed at meetings of the American Society of Mechanical Engineers. The object is not to secure standardization of the electrical features or of the general mechanical design of motors, as this should be left entirely to the individual judgment of each motor manufacturer, but to secure the adoption, for motors of the same rated capacity, of standard dimensions for over-all height and width, location of bolt holes in the base, height of shaft center, length of pulley shaft and location of the pulley. This would permit motors for different current requirements to be used interchangeably and would be of great convenience to both the machine tool builder and user.

There are great difficulties to be overcome in all standardization work, and the motor manufacturers would have to change many of their designs and patterns to meet the new dimensions, but the British Thompson-Houston Co., Ltd., already has solved this problem of motor manufacture and has placed on the market a line of motors designed primarily for machine tools and other power-operated machinery in which motors of the same ratings, both for alternating and direct current, are made with the same essential dimensions to insure interchangeability. Similar progress has been made in Germany, where the two largest electrical companies have cooperated in standardizing basic dimensions.

It would be of great advantage both to builders and users of machine tools if similar interchangeability of electric motors could be effected in this country.

* * *

THE PRACTICAL MAN AND THE THEORIST

The practical man is not always in sympathy with the theorist. The former deals with known facts and is often skeptical of those who delve into mere theories. The practical man recognizes definite limitations and tends to accept them as final, instead of attempting to overcome them. The theorist on the contrary is like an explorer, seeking unknown territory.

The practical man used to say that metal-cutting tools would dull too rapidly if the speeds exceeded certain limits. The theorist recognized these same limitations, but began to think about possible improvements in the physical properties of tool steels. So eventually the practical man was supplied with alloy steels that retained their hardness at temperatures high enough to ruin quickly the best carbon steel. This metallurgical discovery made it possible to greatly increase cutting speeds and thus produce much more in a given time.

But the theorist was not satisfied and began experimenting with other special alloys of an entirely different kind, with the result that further important developments in high-speed metal cutting have been made; and the research work of the theorist will continue indefinitely along this and many other lines, because he knows that mere theories often develop into good practice. It is evident, then, that the theorist who makes the theories of today the practice of tomorrow, is a practical man himself.

Machinist, Toolmaker, and Electrical Apprentices at the Allis-Chalmers Mfg. Co.

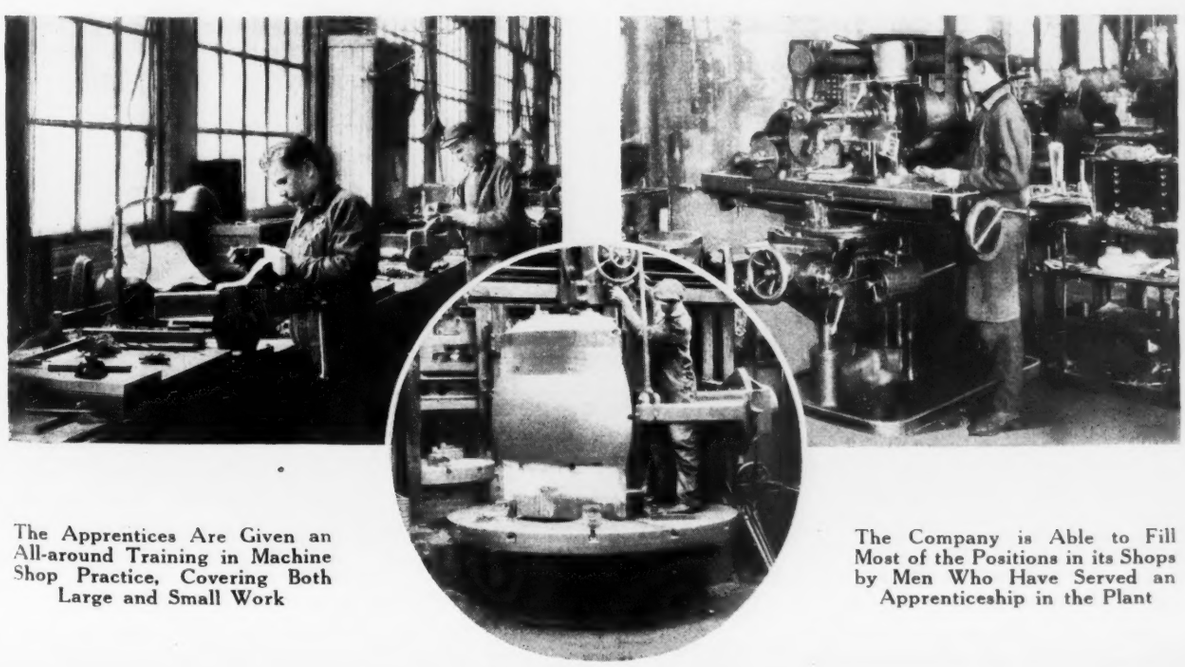
Keeping a Record of Apprentices

A VERY complete apprentice system is maintained by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. Almost every trade in the metal-working field is taught. At present, there are over 340 apprentices. Of these, 124 are learning the machinist's trade, sixteen being toolmakers. Other trades in which boys are trained include patternmaking, with thirty-nine apprentices; molding, with forty-eight apprentices; blacksmithing, with four apprentices; woodworking, with three apprentices; electrical work, with thirteen apprentices; welding, with three apprentices; and boilermaking, with seven apprentices. These boys all serve a regular four-year apprenticeship.

In addition, there are forty-two draftsman apprentices in a three-year course, and forty-six engineering graduates who take a two-year course; and also fourteen students who are taking cooperative engineering courses at universities and who work half of the time for a period of five years with the Allis-Chalmers Mfg. Co.

Besides the general apprentice supervisor, there are eleven instructors who give their entire time to supervising and instructing the apprentices. One of the interesting features of the system as applied by this company is the complete record that is kept of the ability and personal qualifications of the apprentice during his entire period of apprenticeship. Every month the apprentice supervisor and the department superintendent or foreman determine upon the marks that should be given the boy for his work during the preceding month.

These marks relate not only to his general ability, but to the interest and application that he shows in his work, his aptitude, reliability, confidence, conduct, accuracy, speed, knowledge of



The Apprentices Are Given an All-around Training in Machine Shop Practice, Covering Both Large and Small Work

The Company is Able to Fill Most of the Positions in its Shops by Men Who Have Served an Apprenticeship in the Plant

the work, initiative, and attendance. The grades are marked A, B, C, D, and E, the percentages of each grade being indicated in Fig. 1, which shows the form used monthly in reporting the grading of the applicant to the general supervisor's office. Here the record is transferred to a sheet like that indicated in Fig. 2, on which the entire record of the apprentice for his complete course is noted month by month, the sheet being ruled the same on the back as on the front, so that one sheet is sufficient to cover the entire course.

NAME

DEPARTMENT

	INTEREST	APPLICATION	APTITUDE	RELIABILITY	CONFIDENCE	CONDUCT	ACCURACY	SPEED	KNOWLEDGE OF WORK	INITIATIVE	ATTENDANCE

GRADE	A 90-100	B 80-90	C 70-80	D 60-70	E BELOW 60
INTEREST	ENTHUSIASTIC	VERY INTERESTED	INTERESTED	LACKS INTEREST	
APPLICATION	VERY INDUSTRIOUS	GOOD WORKER	STEADY	FAIR	
APTITUDE	VERY QUICK TO LEARN	APT	LEARNS RAPIDLY	SLOW TO LEARN	
RELIABILITY	TRUST-WORTHY	RELIABLE	SATISFACT'RY	IRREGULAR	
CONFIDENCE	EXCELLENT	SELF RELIANT	CONFIDENT	LACKS CONFIDENCE	
CONDUCT	EXCEPTIONAL	VERY GENTLEM'NLY	WELL BEHAVED	TROUBLE-SOME	
ACCURACY	EXCEPT'NALLY ACCURATE	ACCURATE	AVERAGE	INACCURATE	
SPEED	VERY RAPID	RAPID	GOOD	SLOW	
KNOWLEDGE OF WORK	EXCELLENT	VERY GOOD	GOOD	POOR	
INITIATIVE	EXCELLENT	VERY GOOD	GOOD	POOR	
ATTENDANCE	EXCELLENT	VERY GOOD	GOOD	POOR	

REMARKS

DATED

Fig. 1. Card on which the Apprentice's Record for the Preceding Month is Indicated

There are many advantages to be gained from such a record. In the first place, it represents a permanent statement as to what class of work the boy has done during his apprenticeship and how he was rated in each department. When a boy is transferred from one department to another, if he should happen to make what appears to be a poor record after having given a good account of himself in the past, a warning signal is immediately set up showing that the matter should be investigated and the cause for the boy's falling off removed, if possible. A progress report is also sent to the parents or guardians of the apprentice, although the actual marks or ratings are not transmitted. Sometimes the record will show that the boy is not suited for the particular trade in which he has been apprenticed, and in such a case he may be changed to another trade for which he may be deemed more suitable.

In addition to the regular work of the apprentices, special features are included in the apprenticeship, which are varied from year to year with a view to broadening the boys. Thus, for example, the first-year boys are taken, in groups of five or six, through the different departments of the plant to give them an idea of the work that is being done and the ramifications of the activities of the company with which they are apprenticed.

During the second year, machinist apprentices are sent through the tool-rooms—three or four boys at a time—a few hours being spent in learning how the tools that they use in their regular daily work are made. The toolmaker apprentices are likewise taken into the shops at regular intervals for a few hours to see how the jigs and fixtures and other tools that they have been working on are actually used in the shop.

During the third year, the boys are taken on shop trips, especially to see new equipment and to

ALLIS-CHALMERS MANUFACTURING COMPANY Form MA-57A 8-15-25

APPRENTICE RECORD

CLASS DATE

NAME DEPARTMENT WORKS

MONTH	CLASS OF WORK	HOURS	RATE	1	2	3	4	5	6	7	8	9	10	11	AVERAGES
TOTALS															

GRADES

A 90-100 B 80-90 C 70-80 D 60-70

1. INTEREST
2. APPLICATION
3. APTITUDE
4. RELIABILITY
5. CONFIDENCE
6. CONDUCT
7. ACCURACY
8. SPEED
9. KNOWLEDGE OF WORK
10. INITIATIVE
11. ATTENDANCE

DISPOSITION

COMPLETED DISCHARGED

REMARKS

BONUS

Fig. 2. Apprentice Record Maintained in the General Apprentice Supervisor's Office, Giving a Complete Record of a Boy's Whole Apprenticeship

become familiar with different methods of changing speeds and feeds, etc. In the fourth year, the boys are given talks by engineers on the elements of hydraulics, steam, electricity, and other types of machinery built by the company. Shop executives also talk to them on the general subject of shop management and the broad problems of the industry. In addition, there is a general assembly of all apprentices at intervals, when lectures are given on safety and hygiene and other subjects of particular value and interest to them.

All trade apprentices are sent to vocational school five hours per week until they have completed 400 hours of the required academic work. The apprentice is paid his regular wages by the company during this time. If at the completion of the required 400 hours, he shows interest in his school work, he is allowed to continue this work until the completion of his apprenticeship, under the same arrangement.

The result of the apprenticeship system maintained by the Allis-Chalmers Mfg. Co. has been very gratifying, and it is the custom to make all promotions within the plant, as far as possible, from among those who have been trained in the shop. At present, thirty of the foremen in different departments of the company are former apprentices, and many of the shop executive positions are held by men who had their mechanical training with the company.

An apprentice system that is maintained on a large enough scale so that it will supply the needs of a plant for skilled mechanics, foremen, and shop executives, is an ideal for which all manufacturing organizations should work. It is gratifying to note that several of the large plants in the country have practically achieved this ideal.

* * *

STANDARDS OF MEASUREMENT

By SAMUEL S. DALE

I find on page 83 of September MACHINERY, in a reply to a correspondent's question, the following passage taken from the Bureau of Standards Circular No. 535 as authority for your statement that "there is an unfortunate difference in the relation between the standards of measurements as defined in the United States and Great Britain":

"There is at present a slight difference in the official relation between yards and meters in the United States and in Great Britain. In the United States, the official relation is:

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3600}{3937}$$

"In Great Britain the official relation is:

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3600}{3937.0113}$$

"From these relations may be derived the following approximate relations:

1 United States inch = 25.40005 millimeters.
1 British inch = 25.39998 millimeters."

The Bureau of Standards circular is in error, as is shown by the following facts:

1. The law of 1866 making it lawful to use the metric system in the United States defined the meter as 3937/3600 of a yard, the yard being thus recognized as fundamental. This established a meter in the United States slightly shorter than the French meter of 39.370113 inches.

2. The standard yard of Great Britain has been accepted as the standard yard of the United States from the first settlement of this country. On July 8, 1879, the Coast and Geodetic Survey, then in charge of the custody and verification of standards, made this official statement: "There is no difference between the standards of length of Great Britain and those of the United States."

3. On April 5, 1896, T. C. Mendenhall, superintendent of the Coast and Geodetic Survey, issued an order in which the legal relation between the yard and meter established by the law of 1866, 1 meter = 3937/3600 yard, was reversed so as to become 1 yard = 3600/3937 meter, on the assumption that the meter was fundamental. This change made it appear that the yard in the United States is longer than the yard in Great Britain.

4. As the exclusive power to fix the United States standard of weights and measures is lodged in Congress by the Constitution, it follows that the Mendenhall order had no effect on the legal standard-yard and that the only difference is between the meter established by Congress in 1866 for legal proceedings and the construction of contracts, and the meter as recognized by the International Bureau of Weights and Measures at Sevres, France.

5. In the circular from which you quote, the Bureau of Standards proposes a new relation between the English and metric units by which the yard is made 0.9144 meter, and the meter 39.37007874 inches. The bureau, it is gratifying to know, does not intend to repeat the mistake of 1893 by attempting to fix the standard by executive order, but proposes that a new standard shall be fixed by Congress. Even if Congress should establish the standard recommended by the bureau, the fictitious relation promulgated by the order of 1893 would survive in a mass of official and scientific reports, literature, and formulas, and, what is even more serious, in the minds of scientists and educators, where it has been embedded during the last thirty-four years. As a result, we would then have three different lengths of the meter to deal with:

1. The actual relation as established by Chaney and Benoit at the International Bureau of Weights and Measures, 1 meter = 39.370113 inches.

2. The relation legalized in the United States for the construction of contracts and legal proceedings, 1 meter = 39.37 inches.

3. The new relation proposed by the bureau's circular No. 535, 1 meter = 39.37007874 inches.

I would suggest that instead of introducing new ratios between yard and meter, the United States Bureau of Standards conform to the relation 1 meter = 39.370113 inches, as established at the International Bureau of Weights and Measures by Chaney and Benoit, leaving the 39.37-inch meter to be used as the law of 1866 so wisely provided, for the construction of contracts and for legal proceedings.

Tooth Pressures for High-speed Gears*

Effect of Velocity and Pitch on Allowable Pressures, and Application of Formulas

By A. A. ROSS, Engineer, General Electric Co., Lynn, Mass.

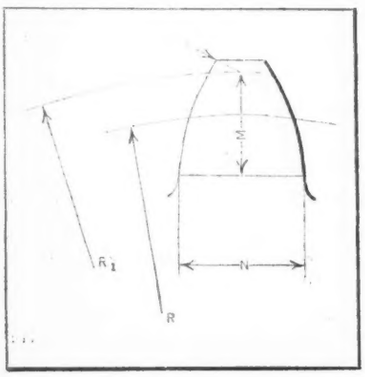


Diagram Showing Values Used in Formula for Tooth Shape Factor

ALLOWABLE tooth pressures for high-speed gears is mostly a matter of experience. In the field of low-speed work involving velocities up to 4000 feet per minute, there is a wide range of experience on which much valuable data has been based, and in this field the load-carrying capacities of gears can be said to be fairly well established. With velocities above 4000 feet per minute, the available data is limited to the experience of the comparatively few manufacturers specializing in high-speed applications. Based upon his individual experience, each manufacturer has attempted to develop formulas from which allowable tooth pressures can be figured.

The company with whom the writer is associated has confined herringbone gear work exclusively to high-speed applications, having developed its first units for turbine-driven generator sets and later extended it to turbine-driven pumps and geared marine sets, and speed-increasing gears for turbine- and motor-driven centrifugal compressors. Typical tooth pressures taken from these applications have been used as a basis in developing formulas. The material, tooth shape and size, and pitch-line velocity are also taken into consideration.

Using 0.40 to 0.50 heat-treated carbon steel, an allowable static stress of 12,500 pounds per square inch is used. Considering that this stress is localized near the root of the tooth, a formula based upon the tooth shape for 1 diametral pitch has been developed, which will give the allowable static pressure per inch of face at the pitch line. This formula contains a value known as the tooth shape factor, the same as the well-known Lewis formula. This factor Y is based on the formula for a cantilever beam loaded at the end, and is as follows:

$$Y = \frac{N^2 \times R_1}{6 \times M \times R}$$

where N = thickness of tooth at plane of maximum stress (see illustration);

M = distance from the point where the line of applied load intersects the center line of the tooth, to the plane of maximum stress;

R_1 = radius from center of pinion to intersection of center line with line of applied load; and

R = radius of pitch circle.

R and R_1 are introduced to bring the pressure to the pitch line. The values of Y for various numbers of pinion teeth are given in Table 1.

Load per Inch of Face

In using this tooth shape factor Y, we have $L = S \times Y$, where L = allowable tooth load, in pounds at pitch line for 1 inch of face and 1 diametral pitch; and S = allowable material stress, in pounds per square inch = 12,500. As this value gives only the static load, it must be further affected by a pitch-line velocity factor. Various formulas for this factor have been devised, one being $\frac{600}{600 + V}$, and another $\frac{3000}{3000 + V}$, where V = velocity at pitch line, in feet per minute.

Both of these formulas, we believe, were developed from experience on low-speed work (up to about 4000 feet per minute), and our experience indicates that they give factors that are much lower than can safely be used for velocities above 4000 feet. Therefore, the following formula has been developed: $K = \frac{78}{78 + \sqrt{V}}$ where K = velocity factor.

In applying this formula, it will be found that K varies from about 0.55 to 0.40 for pitch-line velocities ranging from 4000 to 12,000 feet per minute. Experience has shown that for satisfactory operation at a pitch-line velocity of 4000 feet per minute, gears must be cut as accurately as is commercially possible, and if this is done, the increase in velocity will have little effect on the allowable tooth pressure until a speed is reached at which the centrifugal force may render it difficult to retain an adequate oil film on the teeth. The velocity at which this condition may occur is not def-

Table 1. Tooth Shape Factors—20-degree Pressure Angle (Plane of Rotation) and 82 Per Cent Stub Tooth

No. of Teeth	Factor Y for Tooth Shape	No. of Teeth	Factor Y for Tooth Shape	No. of Teeth	Factor Y for Tooth Shape
20	0.382	34	0.435	48	0.462
22	0.392	36	0.441	50	0.465
24	0.402	38	0.445	52	0.467
26	0.410	40	0.449	54	0.469
28	0.418	42	0.453	56	0.471
30	0.424	44	0.456	58	0.473
32	0.430	46	0.459	60	0.475

Machinery

*Based upon paper read before the American Gear Manufactuurers' Association.

initely known, but we have run gears as high as 14,000 feet per minute without any ill effects being apparent, or any evidence of lack of lubrication. Inserting the K factor in the formula we now have:

$$L = S \times Y \times K$$

Reduction in Allowable Pressures for Larger Teeth

The preceding formula for L gives the allowable tooth pressure on a tooth of 1 diametral pitch for a given velocity and a given number of teeth in the pinion. There remains, then, the factor for the size of the tooth, or in other words, the diametral pitch.

Table 2. Factors (P) for Diametral Pitches

Diametral Pitch	Factor P	Diametral Pitch	Factor P
4	5.25	10	10
5	6.15	12	12
6	6.80	14	14
8	8.35	16	16

Machinery

As far as stress at the root of the tooth is concerned, the allowable tooth pressure would be in proportion to the diametral pitch, but as the stress at the root of the tooth for high-speed work is not necessarily the limiting feature in determining the carrying capacity, we believe that on the larger teeth where greater tooth surfaces are involved, a somewhat greater amount of wear might occur, and possibly there might be a few more irregularities in tooth profile than on the smaller teeth. Consequently, the allowable pressure on the larger teeth has been reduced to about 475 pounds per inch of face for a 31-tooth pinion of 4 diametral pitch and a pitch-line velocity of approximately 7500 feet per minute.

The average allowable loads per inch of face for a 31-tooth pinion having a speed of 7500 feet per minute are, in accordance with actual service operation, as follows:

4 D. P...475 pounds	10 D. P...250 pounds
5 D. P...400 pounds	12 D. P...200 pounds
6 D. P...350 pounds	14 D. P...175 pounds
8 D. P...300 pounds	16 D. P...150 pounds

In solving for the diametral pitch factor from the loads just given, we find that for a 10-pitch tooth, the factor would be equal to 10. Thus,

$$L = \frac{S \times Y \times K}{\text{D. P.}} = 250 \text{ pounds}$$

Also that, dividing by the diametral pitch for 12, 14, and 16 pitches, we find the resulting loads varying only slightly from those agreeing with actual service. Hence this diametral pitch factor, or P factor as it is termed, may for practical purposes be the same as the diametral pitch for 10-, 12-, 14-, and 16-pitch teeth. For larger teeth, factor P is increased as the size of the tooth increases, thereby reducing slightly the allowable load over what would be obtained if the diametral pitch were used. Factors P for various diametral pitches are given in Table 2.

In summing up the various factors, we have the Y factor taking care of the stress and form of the tooth; the K factor taking care of the velocity, which, being based on actual performance, must also contain at least a part of the wear factor; the P factor which is the correction for the size of tooth and also takes into consideration the larger tooth surfaces of the coarser gears. Since P is somewhat larger than the diametral pitch for the larger tooth sizes, the general formula for L is as follows:

$$L = \frac{S \times Y \times K}{P}$$

Since L equals the allowable tooth load per inch of face

$$H = \frac{L \times V \times F}{33{,}000}$$

in which H = horsepower that can safely be transmitted, and F = face width, in inches. Therefore,

$$H = \frac{S \times Y \times K \times V \times F}{P \times 33{,}000}$$

As will be seen, this is the Lewis formula modified to increase the velocity factor and also to decrease the allowable pressure on the larger teeth.

To illustrate the application of this formula, assume that the number of teeth is 34; diametral pitch, 5; pitch-line velocity, 6870 feet per minute; and face width, 10 inches. What is the safe power transmitting capacity?

Table 1 gives the value of Y as 0.435, and Table 2 gives the value of P as 6.15. Velocity factor $K = \frac{78}{78\sqrt{6870}} = 0.48$. Then

Table 3. Tooth Loads and Related Factors—Based on Typical Installations

Diametral Pitch	No. of Teeth	Pitch-line Velocity, Feet per Minute	Tooth Pressure, Pounds per Inch of Face	Tooth Shape Factor Y	Speed Factor K	Pitch Factor P
4	35	8325	474	0.438	0.460	5.32
4	41	9700	468	0.450	0.440	5.28
5	29	7500	380	0.421	0.470	6.52
5	31	5000	447	0.427	0.525	6.26
5	34	6870	400	0.435	0.475	6.45
6	29	6810	337	0.421	0.485	7.60
6	37	10560	300	0.442	0.430	7.75
6	40	6060	400	0.448	0.500	7.00
6	46	7275	294	0.459	0.477	9.30
8	34	10958	200	0.435	0.425	11.52
8	35	5375	320	0.438	0.520	8.90
8	37	10680	267	0.442	0.430	8.90
10	28	7865	224	0.418	0.475	11.10
10	47	4640	262	0.460	0.535	11.75
10	47	4650	334	0.460	0.535	9.22
10	53	5090	336	0.468	0.525	9.15
10	53	8925	288	0.468	0.450	9.15
14	20	5810	148	0.382	0.507	16.30
14	51	6825	179	0.465	0.485	15.75

Machinery

$$H = \frac{12{,}500 \times 0.435 \times 0.48 \times 6870 \times 10}{6.15 \times 33{,}000} = 880$$

This result (880) is nearly five times greater than would be obtained with the ordinary Lewis formula in which the velocity factor $\frac{600}{600 + V}$ is used, but since the higher values obtained with the modified formula given in the foregoing agree with

the actual performance of high-speed gearing, it is evident that the power ratings obtained with the ordinary Lewis formula can be greatly increased, especially for comparatively high speeds. In other words, actual gear performance has shown that it is unnecessary to make such large reductions in allowable tooth loads for the higher velocities.

In Table 3 are given typical tooth pressures and factors Y, K, and P obtained from installations such as turbine-driven generators, pumps, marine drives, and centrifugal compressor drives. By comparing factors P with those given in Table 2, it will be noted that most of them are higher. This is due to the fact that the gears are not operated at their full designed capacity, and where some of the values are considerably higher, it indicates that a standard unit was used considerably under loaded, instead of developing a new gear.

Why Arc of Action is Not Introduced

The arc of action, or the number of teeth in mesh at any one time in the plane of rotation, is another factor that might influence the allowable tooth load. The arc of action depends largely on the pressure angle and the length of tooth. With these two factors constant, the arc of action will vary only slightly as the relative diameters of the pinion and gear arc change, or as the ratio changes.

With the tooth we are using (20-degree pressure angle and 35-degree helix angle) the arc of action ranges between approximately 1.6 and 1.8, and with this condition we are obtaining satisfactory life and operation. Consequently, this factor may be considered constant, and it is taken care of in the curves that are based on performance. For this reason, no separate factor for arc of action has been introduced in the calculation.

If pronounced changes in the arc of action should prevail, it would be due to changes in the pressure angle and the length of tooth, or to the use of long and short addenda combinations. As the first two factors would necessitate a change in hobs, which, along with the use of long addendum, would not be consistent with an adopted standard, the arc of action automatically becomes practically constant, and therefore does not require a separate factor.

There is still another factor that enters into the carrying capacity of the gear and that is the utility factor for application. At the present time we are using factors as follows:

	Factor
Turbine-driven generators	0.95
Turbine-driven centrifugal pumps	1.00
Turbine-driven centrifugal compressors	1.05
Turbine-driven ships (continuous service)	1.25
Motor-driven pumps and compressors	1.05
Motor-driven ships	1.25

In using these factors, the horsepower required for the gear is multiplied by the factor to obtain the horsepower for which the gear should be designed.

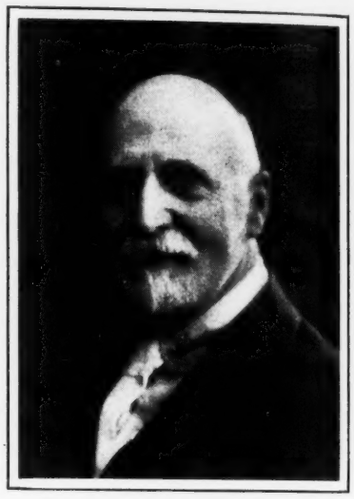
* * *

It is interesting to note that four countries have 90 per cent of all the automobiles used in the world—the United States, the United Kingdom, France, and Canada. These countries have only 11 per cent of the world's population.

ALEX DOW HEADS MECHANICAL ENGINEERS

Alex Dow, president of the Detroit Edison Co., has been elected president of the American Society of Mechanical Engineers for the year 1928.

Mr. Dow was born in Glasgow, Scotland, April 12, 1862. As a boy with a few years of schooling, his ambition was to become a marine engineer, but circumstances balked his ambition and he went to work before he was twelve years old as a messenger in a railroad office, continuing in the same employment for six years, first as junior clerk and then as stenographer. Later he was employed by the Cunard Line in its Liverpool office. At that time he spent his spare hours in the engine rooms of the steamships.



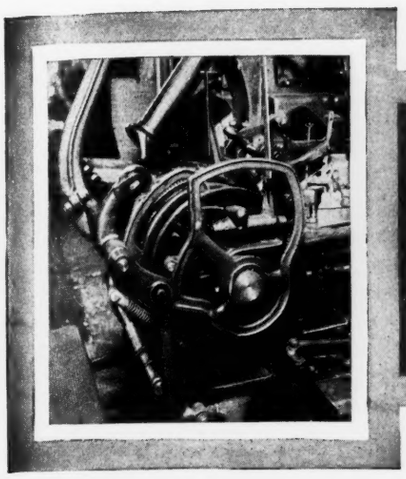
Alex Dow, New President of the American Society of Mechanical Engineers

In 1882 he came to the United States and was first employed by the Baltimore & Ohio Railroad. He was later transferred to the Baltimore & Ohio Telegraph Co., and was placed in charge of local line and instrument maintenance. In 1888 he went to the Brush Electric Co. of Cleveland, Ohio, manufacturer of Brush arc-light dynamos and other electrical machines. At first he was installation electrician in the Chicago office, and in the following year he became district engineer in Chicago.

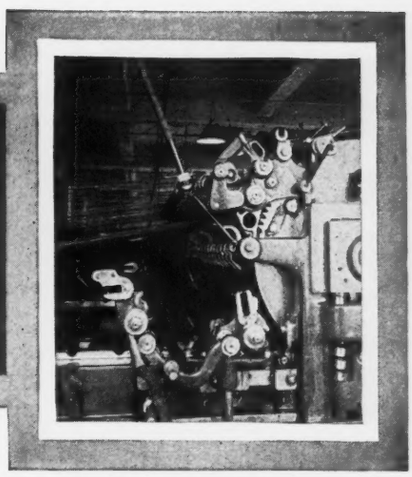
In 1893 he went to Detroit to design and supervise the construction of the public lighting plant of the city of Detroit, and in 1896 he took charge of the Edison Illuminating Co. of Detroit, holding the position of vice-president and general manager. In 1903 the Detroit Edison Co., of which Mr. Dow is now president, succeeded the earlier organization. Together with engineers whom he has associated with himself as his staff, Mr. Dow designed and built not only the Conners Creek plant in Detroit, but also the Marysville and Trenton Channel plants.

Although a graduate of no university or technical school, Mr. Dow received the honorary degree of Master of Engineering from the University of Michigan in 1911, and the honorary degree of Doctor of Engineering in 1924.

Mr. Dow became a member of the American Society of Mechanical Engineers in 1895, and is also a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the Institution of Electrical Engineers of Great Britain. He is a charter member and past president of the Detroit Engineering Society. He has served the city of Detroit as the engineer member of the Board of Water Commissioners, and is now engaged in the construction of a duplicate water service, being for a third term president of the Board of Water Commissioners.



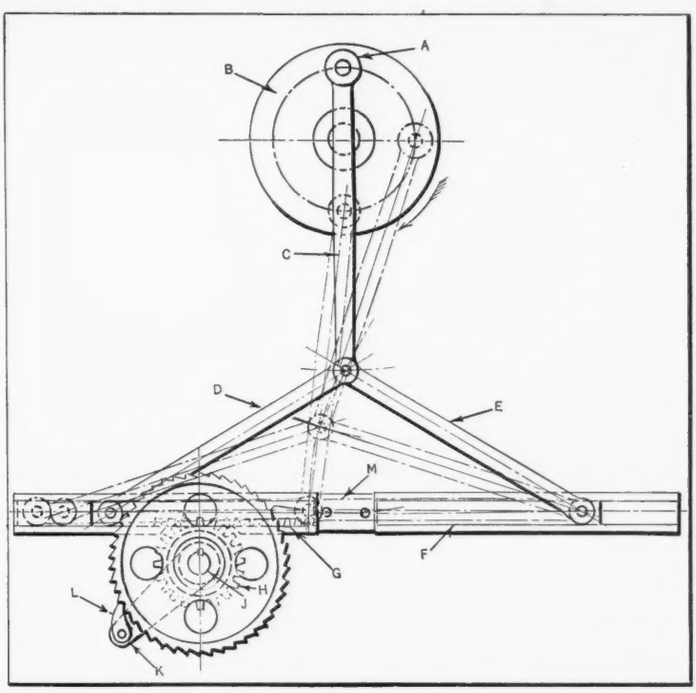
Ingenious Mechanical Movements



NON-STOP FEED RATCHET ADJUSTMENT—1

By F. H. STIENING

Ordinarily, the feeding movement obtained with a ratchet feeding mechanism is varied by changing the radial position of the operating crankpin, but this is not readily accomplished without stopping the machine. The variable ratchet feeding mechanism shown in the accompanying illustration may be adjusted while operating. It consists of a fixed crankpin *A* mounted on a crank disk *B*, which, in turn, is mounted on a main drive shaft. One end of the pitman *C* is connected to the crankpin, and the other end is connected to links *D* and *E*. Fastened to link *E* is a sliding bar *F*, while link *D* is fastened to the rack *G*. Rack *G* meshes with pinion *H*, which is free on feed-shaft *J* but is connected to an arm *K* carrying pawl *L*. This pawl meshes with the ratchet wheel which is keyed to the feed-shaft.



Ratchet Feed Mechanism which may be Adjusted without Stopping the Machine or Driving Crank

Thus arranged, the driving motion of the main shaft is transmitted to the pawl arm with the sliding bar *F* abutting against the block *M;* and if the sliding bar is held against *M* during the downward stroke of the crankpin, all of this motion will be imparted to the pawl arm, swinging the pawl the maximum distance back around the ratchet wheel. On the upward movement of the crankpin, the pawl arm will be pulled upward and the pawl, engaging with the ratchet wheel, will turn the wheel through a maximum degree of rotation.

However, if the sliding bar is allowed to have some movement away from block *M* and the movement of the rack and pawl arm is impeded, part of the downward motion will be transmitted to the sliding bar and subtracted from that of the pawl arm, depending upon how far the sliding bar, on the one hand, and the rack and connected elements, on the other hand, are allowed to move. For example, if no limit is placed on the movement of the sliding bar, and no movement of the rack and connected parts is allowed during the downward stroke of the crankpin, all of the movement will be imparted to the sliding bar, and on the upward stroke of the crankpin, the sliding bar will merely come back to *M*, and there will have been no feeding motion imparted to the ratchet wheel and feed-shaft.

It will thus be seen that by regulating the proportion of movements of the sliding bar and the rack, any desired degree of rotation of the ratchet wheel and the feed-shaft may be effected. Suitable arrangements may be provided for setting the position of the sliding bar for each stroke of the machine. This can be easily done without stopping the machine. This mechanism is especially suitable for feeding structural steel, etc., through a punching machine, where the spacing of the holes is variable. The main drive shaft then represents the main shaft of the punching machine.

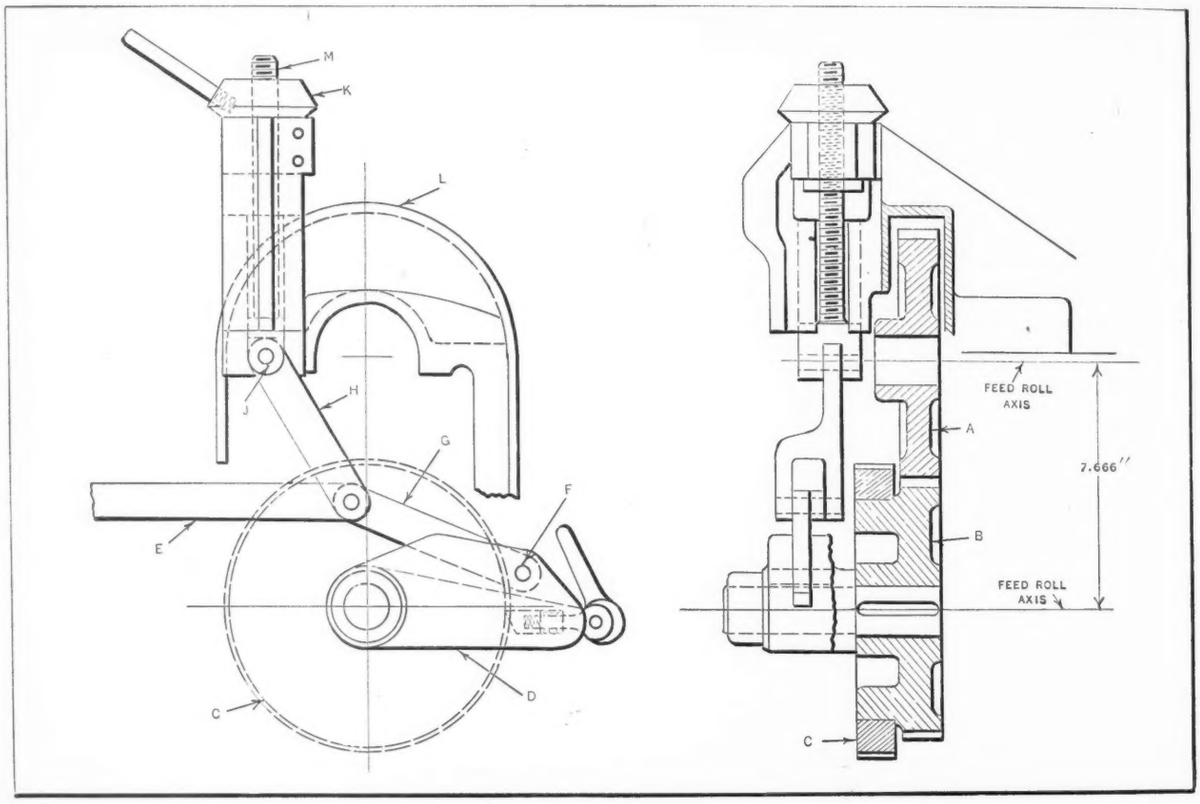
* * *

NON-STOP FEED RATCHET ADJUSTMENT—2

By A. W. JANSSON

Many machines in our plant have feed rolls in one form or another, the two roll shafts being geared together, as for example, by gears *A* and *B*

(see illustration). The lower shaft has a ratchet wheel *C* operated by a pawl carried by lever *D*, which, according to the former arrangement, was given a reciprocating movement by the direct action of a connecting-rod *E* pivoted to it, the motion imparted to *E* depending upon the radial position of a crankpin. When connecting-rod *E* is directly connected to lever *D*, changes in the feeding movement requires stopping the machine in order to increase or decrease the radial position of the crankpin (not shown) to which connecting-rod *E* is attached. Moreover, such trial adjustments may have to be repeated before the desired feeding movement is obtained. In operating these machines, which run at 200 revolutions per minute, it is important to feed the correct amount because the feeding is against a fixed stop; consequently, if the feeding movement is too long, the ratchet teeth and feed rolls wear out very rapidly, and too short a movement would cause scrap blanks.



Another Mechanism for Adjusting Ratchet Feeding Movement without Stopping the Machine

To avoid wasting time in adjusting the feed mechanism and also secure more accurate adjustments, a feed mechanism was designed by the writer which permits varying the feed a very slight amount if desired and while the machine is running at full speed. This improved design is so arranged that the motion is transmitted from connecting-rod *E* to pawl lever *D* through link *G* and a link *H* which swings about a pivot *J* that may be adjusted vertically by turning nut *K*. As pivot *J* is moved upward less motion is transmitted to pawl lever *D*, whereas a downward adjustment of the pivot has, of course, the opposite effect, the feed being increased.

The casting *L*, which supports this adjusting mechanism, has a vertical slot in which the rectangular head of bolt *M* slides as nut *K* is turned. This nut is prevented from moving vertically by the retaining collar seen in the side view. Link *H* is pivoted at *J* to the forked end of bolt *M*. The parts should be so proportioned that link *H* will not swing back beyond the vertical line. Links *H* and *G* of this mechanism measure 5 11/16 inches from center to center of the holes, and connecting-rod *E* is about 4 feet long. The crankpin to which *E* connects is first adjusted roughly to give sufficient motion, and then after the machine is started pivot *J* is adjusted vertically until the feeding movement is exactly what is required. This mechanism works perfectly, and not only saves time, but has lengthened the life of both ratchets and feed rolls. Although some form of friction ratchet would make it possible to obtain a theoretically perfect adjustment, a positive action is desired for this mechanism. A triple form of pawl now is used. The distance between these pawls is equal to one-third of the pitch of the ratchet wheel teeth; hence, in effect, the ratchet wheel has three times the actual number of teeth, so that comparatively fine adjustments are possible without eliminating the positive drive.

* * *

SAFETY DEVICE FOR MACHINES HAVING REVOLVING CYLINDER IN OUTER CASE

By CHARLES M. OTIS

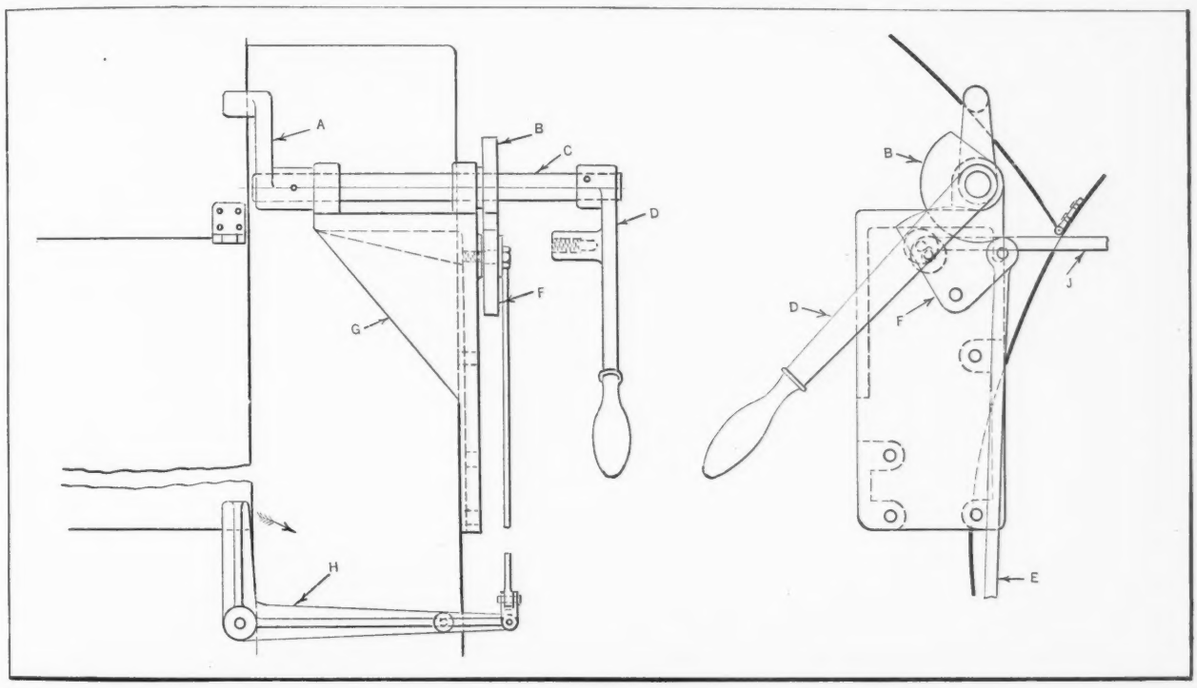
Several states have adopted a rigid safety code with respect to the operation of machines in the various industries. One of the requirements of this code deals with machines having a revolving cylinder within an outer case or shell, such as tumblers, etc. With such an arrangement, the cylinder

must be brought to a stop before the outer case door can be opened, and when the outer case door is open, it must be impossible to start the machine. It was in an effort to solve this problem that the interlocking device here described was devised. It is so simple and effective and consists of so few parts that it might find application to many similar problems.

The handle *D* is pinned to one end of a short rod running through a bracket *G* which is fastened to the frame of the machine. On the other end of the rod is pinned the lever *A*. When the door of the hinged outer case is raised, it bears against the projection of this lever. There is a spring catch in a bracket at the other end of the door (not shown), which holds the door from dropping when it is opened all the way.

Handle *D* carries a connecting-rod to the belt-shifter at the rear of the machine, and when the handle is pulled forward, it throws the belt shifter in neutral and also applies a brake. With *D* in the forward position, lever *H*, which covers the door when it is closed, can be pushed down, releasing the door, but it cannot be pushed down until handle *D* is pulled forward, on account of the shape of the under side of the cam *B*, which is pinned to the same shaft as handle *D*. When *H* is pushed down, however, it will be seen that the cam *F*, connected to it by connecting-rod *E*, swings under *B*, preventing the handle from being moved and possibly starting the machine.

Thus we have met the conditions that the machine cannot be accidentally started while the outer case door is open, and the outer door cannot be opened until the belt shifter is in its neutral position. Lever *A* prevents the operator from stopping the machine, pushing down lever *H* momentarily to release the door, and then raising it again when the door is opened. This would permit handle *D* to be pushed forward again, starting the machine; but the door being hinged, will drop of its own weight, unless opened far enough to be held by the spring catch mentioned, and when thus held, it rests against *A* and prevents handle *D* from being moved.



Safety Device Designed for Tumblers or Other Machines Having a Revolving Cylinder within an Outer Case

* * *

COVER FOR DRAWING-BOARD

On page 859 of July MACHINERY there is an article describing the use of a window shade as a cover for a drawing-board. In a shop where I was chief draftsman for some time, the drafting-room had thirty or forty boards equipped with this type of cover, and my experience with them was not very satisfactory. I found that the following regular cycle of operations ensued: The sweeper, as is often the case, cleaned the room by tossing all the dust and dirt into the air, and ran away before it came down. The dust and dirt settled on the covers, and when they were rolled up, the dirty side of the cover soiled the clean side. Then when the cover was subsequently drawn over the drawing, the drawing was smeared. The result was that the drawing was not much cleaner than it would have been had it been left uncovered.

Another fault with the use of a fabric cover was that it held a considerable amount of moisture, and in muggy weather the tracing cloth blistered much worse when covered with it than when protected by the customary piece of paper. I discontinued the use of window shades for drawing-board covers. F.

* * *

The two traveling fellowships created by John R. Freeman for the study of hydraulic engineering have been awarded, through the American Society of Mechanical Engineers, to Herbert N. Eaton of the Bureau of Standards at Washington, D. C., and Blake R. Vanleer, professor of mechanical engineering at the University of California, Berkeley, Cal.

What MACHINERY'S Readers Think

Contributions of General Interest are Solicited and Paid for

A FOREMAN'S JOB

The article "A Foreman's Job," on page 833 of July MACHINERY does scant justice, I am afraid, to a large number of working foremen and assistant superintendents. A few observations from another angle may tend to give a different aspect of the assistant superintendent's action. It seems to the writer that the very nature of the work—general repair and maintenance of heavy machinery—calls for a different sort of direction than the ordinary run of repetitive production work. Therefore, the assistant may have had very good reason to jump in, because it is often more effective to "show how" than to "tell how."

Then, again, there is a deeper significance behind the assistant superintendent's action than may appear on the surface. There is usually a very small gap between the foreman's position and that of the assistant superintendent. From my experience with foremen, I have found that they would as soon be called top sergeants as second lieutenants. Those readers of MACHINERY who have had anything to do with either of the aforementioned gentlemen will recollect for whom they had the most respect.

The assistant foreman showed that he "knew his stuff," and you may be sure that as soon as his men knew that he knew, he would not have to jump in very often to help them out.

Here's to the man who knows his stuff
And is not afraid to show it.
There's many a man getting by on bluff,
But not with the men—they know it.

F. H. R.

PROFITING BY EXCHANGING INFORMATION

Have you ever noticed what a great difference there is between men in their attitude toward advice and suggestions given them? How frequently, even when advice is asked for, is it practically ignored when it does not coincide with the inquirer's preconceived opinion. Probably because it costs so little, good advice seems to be the last thing the average man cares to profit by. If the advice confirms our opinions or actions, well and good; but if not, we still think as we thought before.

On the other hand, I know a man who is willing to both give and take advice. He has a plant and equipment second to none, and his manufacturing methods are ahead of most of his competitors, but in spite of this, I never met anyone so ready to accept suggestions, and what is more, so eager to try them out in practice. He never lets an opportunity pass without actually finding out whether suggestions made to him are of value or not. He does not dismiss them because of a mere opinion of his own.

His theory about visitors is that every visitor pays his way, and the better informed the visitor is, the greater is the profit from his visit. He is also willing to exchange information, and shows his competitors almost anything in his shop. Generally speaking, I believe that the visitors leave, on the average, more behind them than they take away, because in this shop, if they leave any idea at all offering possibilities of improvement in existing methods, it is tried out at the earliest moment and adopted if found to be satisfactory. Many visitors, on the other hand, are likely to be so convinced of the superiority of their own methods, that they do not profit as much as they could from a visit to another man's plant.

In a general way, it seems that those who have the least to tell are the ones most anxious to keep their knowledge to themselves, while those who know the most, are ready to impart their knowledge to others. Is it not likely that this very readiness to share their knowledge is one of the secrets of their ability and success? Whenever we discuss an idea with someone else, it is likely to become clearer to ourselves, and often we see new points that had not occurred to us before. While I believe that our willingness to accept the suggestions of others is a better index of our enterprise than our willingness to give information, both the giving of information and the accepting of advice are indications of a progressive mind. DIOGENES

GOOD SHOP CONDITIONS PAY DIVIDENDS

Many shops that have appeared to have a fair chance of success have failed because too little thought has been given to working conditions. Adequate consideration has not been given to the feelings of the men working in the shop nor sufficient attention to keeping the shop clean and in order. As a result, labor turnover has been high, with corresponding waste. Excessive labor turnover is a sure indication of a lack of the right kind of shop environment. There are few men who do not appreciate a pleasant and comfortable shop to work in, and most men will do their best working for a foreman who gives them credit for their efforts and who deals with them on a man-to-man basis.

Every good workman likes to be employed in a place where the floors and windows are clean and the light good. It is true that it costs money to clean machines, floors, and windows, but it really costs a great deal more if they are left dirty. Just as surely as the constant dropping of water will wear away the hardest stone, so will a constant association of men with industrial plants that are dirty and ill-kept wear away their morale and their interest in the work they are doing, and cause constant change in personnel—both of shop men and of those in supervising positions. H. L. WHEELER

WHEN SHOP RULES ARE TOO RIGID

In a shop where I spent some years of my life, the rules were very strict, and if they were ever violated under any circumstances, the man guilty of the violation was promptly "fired." Once one of the men rushed away from home without having his breakfast. He had chosen the better of two evils—rather than be late to work he sacrificed his morning meal. In order not to go without something to eat until noon, he obtained a sandwich, however, expecting to eat it while at work. This was against the rules, and as the superintendent saw him consuming his sandwich, he was promptly "fired," in accordance with the regulations.

It is true that he violated a rule, but in view of the high cost of labor turnover and of the injustice that may be done many a man who just oversteps the rules through some unfortunate circumstance, would it not be in accordance with common sense to give a man a hearing and weigh the circumstances before dismissing him? JOHN HOMEWOOD

ENGINEERING QUALIFICATIONS

Mechanical engineers can be divided roughly into two groups—the designer and the executive. The two groups require men of different types with different education, experience, and personality. The designing engineer requires a native ability to concentrate on intricate problems and to visualize mechanisms. He must be a constant student of new books and magazine articles, so as to be informed on new developments. A technical education is, of course, very desirable as a foundation. The technical courses at our colleges today are more suitable for designing engineers than for executives. This is rather strange when we note that the young men are not eager to enter designing work after leaving college, but prefer the executive engineering field.

A good designing engineer has to spend six or eight years after having completed his college education, before he is fully equipped for his work. He should spend at least two years working as a mechanic in shops building the line of machinery on which he will specialize. After this, he ought to have one or two years of tool designing experience, which will prove valuable later in designing machinery. Then he becomes a draftsman in his chosen line, working up slowly or rapidly, according to his ability and opportunities. Ultimately he may hold an executive position and be placed in charge of a drafting-room or designing department, or the entire engineering work of the firm.

In the executive group are superintendents, production managers, and engineers not directly concerned with the design of a product, and these men require different characteristics. They must be able to make decisions rapidly and must carry along a large number of problems simultaneously. Their reading is made up of magazines and books dealing with management, organization, labor, and shop equipment.

A technical course particularly suited for executive engineers would go less deeply into the various theoretical subjects and would deal more with modern production methods, standardization, wage systems, and similar subjects. Such a course should also aim to give the student a good working knowledge of the common trades in the machine-building field, such as molding, forging, pattern-making, toolmaking, and drafting.

After graduating, the man fitting himself for an executive engineering position ought to work for about three years in different shops making various products. One or two years' drafting experience would also be of value. The next step would be work in the production office—routing, scheduling, and rate-setting. The young man is now nearly thirty years old and ready to take a secondary executive position—say, assistant superintendent.

It is impossible to say whether a man should stay with one concern that develops its own executives or move about as opportunities for a better position or greater experience present themselves. Circumstances and judgment will have to decide the best course to pursue in that respect. L. F. S.

USING TRADE JOURNALS IN TECHNICAL SCHOOLS

The writer, being a mechanical instructor in the Sarnia Collegiate Institute and Technical School, wishes to call to the attention of instructors in other technical and trade schools the value of trade journals for instruction purposes. The mechanical department of the school mentioned makes constant use of MACHINERY, filing the back numbers and using them for reference in the school work. Copies of MACHINERY are circulated among the students, who are assigned definite subjects for special study. In many cases the entire subject of study, or "project," as we call it, is centered on some article in the journal. The use of a magazine such as this gives the young students a perspective of the mechanical engineering field that they could not obtain otherwise, except by long years of experience, and we believe that supplementary reading of this character is necessary for students in the mechanical department.

Many other ways in which a technical journal may be made use of by an instructor will readily suggest themselves to the wide-awake educator. In addition, the library of our school contains a full set of all the books published by MACHINERY, from small reference manuals to the HANDBOOK and the ENCYCLOPEDIA, and we find that these books can be used directly in the instruction work both as text-books and reference books. R. M. DURNFORD

WORDS WITH NO DEFINITE MEANING

A man was asked to define the word "mechanism." He said, "A mechanism is a sort of dingus—" The laughs at the word "dingus" prevented him from going further. Yet "dingus," "gagett," "doo-dad," and the like are words in common use among some men in the shop and even in the office. These words have no dictionary definition. They have no place in our language, and we do not need them. The English language contains sufficient words to describe all objects with the finest shade of difference. To use words that "don't belong" is to admit ones deficiency in the use of the language.

AN OBSERVER

Automatic Production of Threaded Shells

Improved Method of Manufacturing Thin-gage Brass and Steel Shells Having Rolled Threads

By FRED R. DANIELS

IN the fabrication of numerous thin-gage shells and formed articles from flat strip metal, the so-called "eyelet" machine has long been regarded as ideal for quantity production. The name "eyelet machine," it should be explained at the outset, is really a misnomer, the term having been applied by the inventor, Robert Cairns, because of the fact that the machine was designed especially for use in the manufacture of brass eyelets, fasteners, etc. However, this machine has grown so rapidly in favor and in range of usefulness, that instead of being used only in the locality of Waterbury, Conn., where it was invented, it is now employed generally for making all sorts of small metallic articles. The original design was of the two-plunger type, but these machines are now made with as many as eight or even ten plungers and fitted with various attachments that extend their usefulness. (See Fig. 1.) Practically any small brass article that can be cut, drawn, formed, pierced, or otherwise fabricated from the strip is now automatically produced complete on this machine.

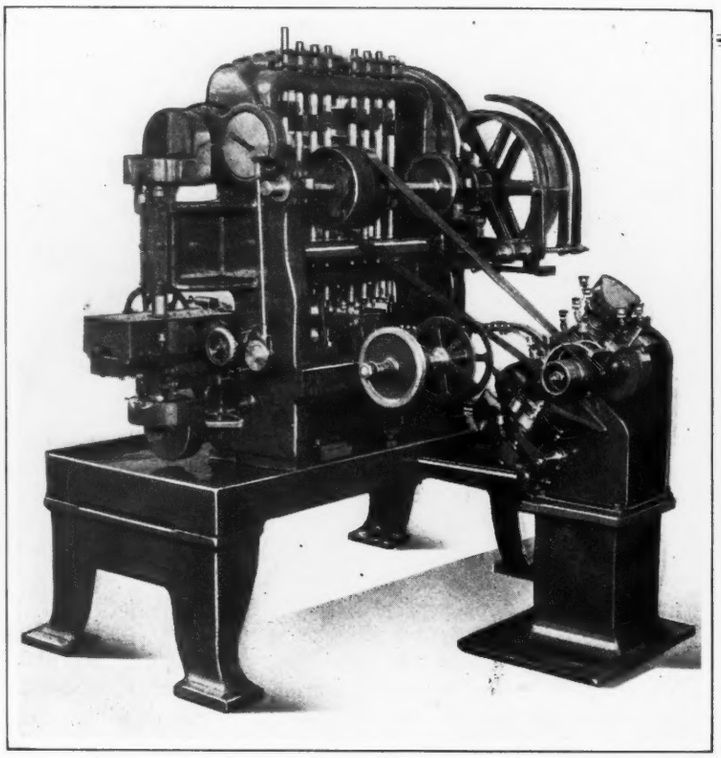


Fig. 1. Inclined Shell Threader Applied to a Standard Eyelet Machine

Briefly described, the eyelet machine is a multiple press, each plunger being controlled by a cam and properly timed. The metal is pulled through from a reel in front of the blanking station by a roll feed at the rear, and the scrap is wound up on a second reel. The metal is blanked between feed movements, and the blank is carried by the punch through the die into a transfer slide beneath, which operates from side to side. The slide carries the blank to the second station at the left, where it dwells until the second plunger descends and draws the blank through the slide into the first cupping die.

When the slide is returned to receive the next blank, the cupped shell is ejected from the second die into a pair of spring fingers, especially shaped to hold the work. These fingers are attached to the slide so that when the second blank is transferred to the second punch, the first cupped shell is transferred to the third station. The slide is fitted with a pair of these fingers at each remaining station, so that the work is intermittently carried from plunger to plunger with each movement of the slide to the left, and there is a succession of shells traveling steadily from right to left.

Combining the Eyelet and Thread-rolling Machines

Although attachments may be applied to this machine for performing operations in a horizontal plane, such as marking and side-stabbing, it has not been possible heretofore to produce a thread without resorting to the use of a second machine, commonly known as a screw-cap thread-rolling machine. Obviously, this entails extra handling and separate drives, and requires nearly twice as much time to produce a threaded shell. All these handicaps to maximum production may be eliminated by making certain changes in the design of the thread-rolling machine, mounting it on an incline, and using it in conjunction with the eyelet machine.

The arrangement referred to is illustrated in Fig. 1, from which it will be seen that the threader is driven by belt from the back-shaft of the primary machine. By inclining the threader, it is not only practicable to run a track or chute from the last station of the eyelet machine to the threader for the shells to travel through, but it is also a simple matter to automatically strip the shells after threading, so that they fall by gravity into a trough leading to a receptacle. Thus, the metal which is fed into the eyelet machine in strip form leaves the threader a completed article, having passed through both machines without manual aid. Moreover, the threading operation actually consumes no extra time beyond that required for making the unthreaded shell; in other words, with every stroke of the eyelet machine, a threaded shell is turned out.

The fact that both machines are driven from the same source does not mean that both are shut down when making tool replacements, repairs, or adjustments on either machine, because the eyelet machine can continue to run while the threader is idle, and the accumulated shells can be threaded when the eyelet machine is temporarily idle. Under normal conditions, however, the two machines function in unison and there is no interruption to the steady flow of work. The unprecedented production of from 70 to 90 shells, 1 inch in diameter and 5/8 inch deep, per minute, is obtained.

How Threads are Rolled

It is not the intention to describe in detail the process of thread rolling except as may be necessary to explain the operation of the inclined thread roller. The threads are formed by pressure between a fixed inside tool and a swinging outside tool, both threaded, and revolving in opposite directions. The tools have the same helix angle and the same surface speed. For small-diameter work, the outside tool *T*, Figs. 2 and 3, is increased in diameter to two, three, or four times that of the inside tool *t*. This shortens the distance between the tools and increases the time between cycles available for unscrewing or stripping. If the tools for small-diameter shells were made equal in diameter, so much time would be required to swing the outside tool into contact with the shell that interference with other mechanisms would occur and the cam "rise" would be too steep for mechanical operation.

The Feed or Carry-in Motion

The eyelet machine is fitted with a cam-actuated rod which pushes the shells from the last die into the chute extending from the rear to the threader. The chute curves down, and the stack of shells is supported by a hinged feed-finger *A*, Figs. 2 and 4, which is shaped at the end to suit the shells. The finger swings in and out from the center line of the chute to the center line of the main spindle by cam action; when it is out, it catches a shell from the chute and carries it into line with the headstock spindle, where it is held until pushed from the finger onto the inside threading tool *t*, Fig. 2.

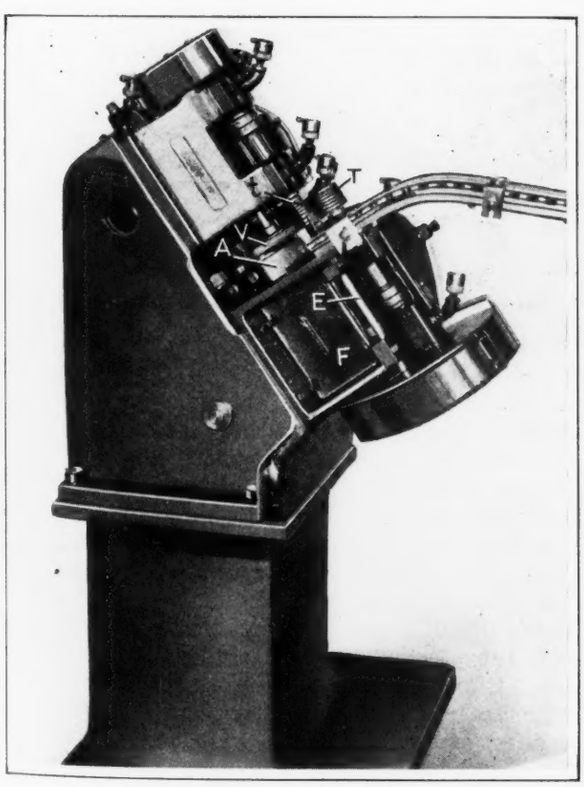


Fig. 2. Operative Side of Shell Threader, Showing Feed Chute

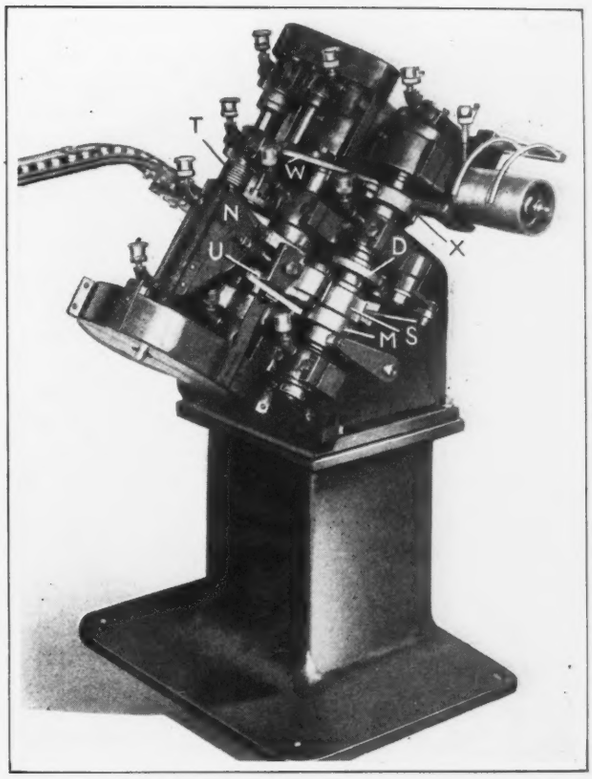


Fig. 3. Drive Side of Shell Threader, Showing Cams, Camshaft, and Operating Mechanism

The exact alignment of the shell with the center line of the inside threading tool is accomplished by adjusting stop-screw *B*, Fig. 4, against which the finger arm holder *C* is held by the tension of a spring; the finger is positively withdrawn to receive the next shell by cam *D*, Figs. 3 and 4. A yielding, adjustable carry-in motion and positive withdrawal are absolutely essential for this mechanism, as can be readily appreciated.

The Lifter or Push-on Mechanism

The lifter device is simply a push-rod *E*, Figs. 2 and 4, with bearings in the feed bracket *F*, which is advanced by a spring *G* to push the shell onto the revolving inside tool and hold it until the threading operation is well started. This rod has a tool-steel head *H*, made to suit the diameter of the shell, which, when the rod is back, seats in a pocket cut in a steel plate *J* attached to the feed bracket facing the headstock. This plate serves as a wearing surface for the side of the swinging feed-finger and also as a guide for the push-rod. During the time that the push-rod remains in the forward position, holding the shell on the arbor, the feed-finger swings away; as it does so, it also swings down on its hinge *K* and snaps under rod *E*

through the action of a spring *L* beneath the finger. This spring is compressed by the contact of the receding finger against the push-rod.

The push-rod remains in the forward position, holding the shell from the end until after the thread has been partially raised; it then recedes by positive cam action and rests until the next shell is fed in. The lifter cam is indicated at *M*, Figs. 3 and 4.

The Swinging Head

The swinging head *N*, Fig. 3, which carries the outside threading tool *T*, is swung down by a cam *S* until the threads have been rolled to their full depth by the pressure exerted. The center distance of the two tools can be adjusted so that the threads will be rolled to the required depth by raising or lowering the cam roll bracket *U*. The outside tool remains at the full depth for one or two complete revolutions, and is then swung up by a spring which keeps the roll in contact with its cam.

The Unscrewing or Stripping Mechanism

The unscrewing device operates while the swinging head is being raised. It consists of a felt roll *V*, Fig. 2, mounted on a pivoted arm *W*, Fig. 3, which is pulled into contact with the revolving shell by a spring and away from it by cam *X*. The felt roll is larger in diameter than the shell and revolves in a counter direction at about five times its surface speed. The contact of the roll with the shell stops its rotation, causing it to unscrew from the revolving inside tool. The roll is driven by a spur gear which, as the roll arm is pivoted, rolls on the pitch circle of an idler in the gear train that drives the main spindle.

The pulley shaft (see Fig. 3) drives the back drive shaft by helical gearing, and this shaft, in turn, drives the swinging spindle by selective change-gears, as already mentioned. The back drive shaft carries a spur gear at its upper end for driving the main spindle at a speed of more than 2000 revolutions per minute. The camshaft is driven by worm-gearing from the pulley shaft, its speed being made to suit the anticipated production. Adjustments which adapt the machine for handling shells from 1/2 inch to 1 1/4 inches in diameter and from 1/4 inch to 1 1/8 inches in length are provided.

* * *

CHROMIUM IN THE METAL INDUSTRIES

Few people outside of the automobile field recognize the importance that chromium steels play in that industry; as a matter of fact, automobiles as known today, would have been impossible without this kind of steel. Chromium is not a rare metal. It is estimated that there is more chromium than copper, and considerably more chromium than nickel in the world. There are deposits of chromium ore in many parts of the world, but at present about 70 per cent of the metal comes from South Africa because of the cheap labor conditions there. In 1925, the production of chromium was 85,000 tons. The output of nickel in the same year was 40,000 tons; tungsten, 6000 tons; and copper, 1,500,000 tons. Chromium imparts to steel hardness and toughness, as well as resistance to corrosion and the effect of high temperatures. Chromium-plating has recently become very important, and it is believed that in the future chromium-plated steel parts will take the place of casehardened parts.

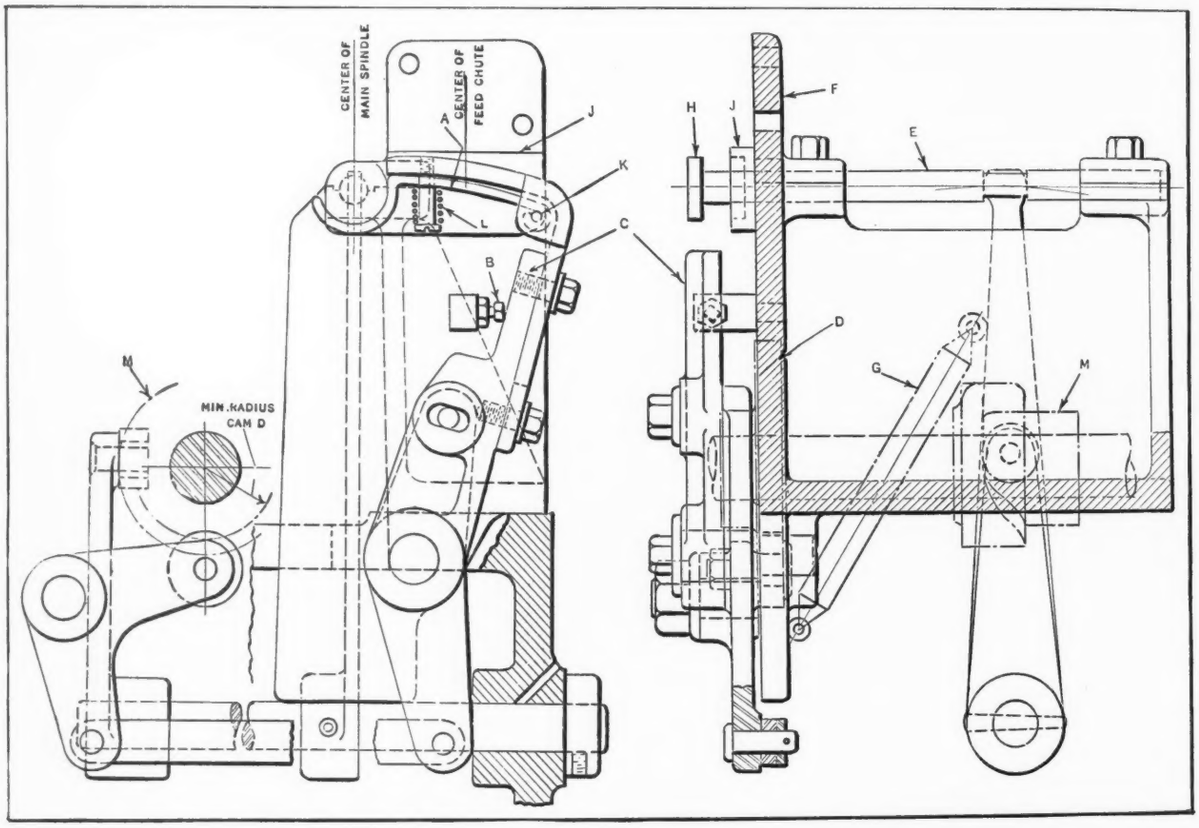


Fig. 4. Partial Assembly View, Illustrating the Operation of the Feed and Lifter Mechanisms

Cause and Effect of Stresses in Castings

By FORREST E. CARDULLO, Chief Engineer, G. A. Gray Co., Cincinnati, Ohio

IN many cases stresses are set up in castings as a result of the difference in temperature in various parts of the casting at the instant that the part which solidifies last assumes its permanent form. As an example, a beam having a lower flange which is very much thicker and heavier than the upper flange will be considered. The lower flange will remain in a fluid state in the mold after the upper flange has solidified. As the cooling process continues, the upper flange drops from the temperature of fusion, which occurs at, say, 2400 degrees F., to some lower temperature, while the lower flange remains at a temperature of 2400 degrees F. and continues to solidify.

Finally when the lower flange has become completely solidified, the upper flange will have dropped to a considerably lower temperature, say 1800 degrees, and there will be a good deal of difference in the temperatures of the two parts of the beam. When they cool down to the same temperature, the lower flange will shrink more than the upper flange. Because of the 600 degrees difference in temperature at the final instant of solidification, the upper flange will be 0.040 inch per foot longer than the lower flange. This causes the beam to bend and take the form of an arc of a circle.

If the temperature of the webbed portion of the beam had changed uniformly between the two flanged portions, so that the part of the web next to the small flange had a temperature of 1800 degrees, while the part of the web next to the upper flange had a temperature of 2400 degrees at the instant of solidification, there would have been no internal stresses in the casting. The casting would then be of stable form, and the removal of any part of the metal would not cause a change in its form.

Such would not be the case, however, as the web, being the thinnest part of the casting, would solidify first and probably would be cooler at its center than either of the flanges. As a result, complicated stresses would be set up and the piece would not bend as much as indicated by the theory outlined. However, if any part of the metal is removed from either of the flanges, the amount of curvature in the beam will change because of the relief of some of the internal stresses.

Factors that Cause Change in Form of Casting

Very few castings are of uniform section. In almost every case some part of the casting is smaller in cross-section and therefore cools quicker than the larger sections. The difference in the rate of cooling between the various sections is usually such that at the instant of final solidification there is not a gradual and uniform difference in temperature in the different parts. Even though the casting is of uniform section, accidents or mistakes in molding, the way in which the casting is gated, differences in the amount of moisture contained in the sand in different parts of the mold, close grouping of flat surfaces in the mold, and various other factors will produce variations in the temperature of the metal at the instant of final solidification.

The result is that very few castings are of exactly the same shape as the pattern from which they were molded or are of the same shape as the mold into which the iron is poured. The pressure on the pattern, developed when ramming up the mold, may distort the pattern slightly. It is obvious that, when the stresses in the casting are relieved by machining, the casting will tend to change its form as soon as the roughing cut is taken. The remedy is to take a finishing cut after the casting has been allowed to assume its natural form. Sometimes the change in the shape of the casting is so great that a second roughing cut may be necessary before the finishing cut can be taken.

An example of this kind of work is a lathe bed of the usual design. Such a casting is generally molded upside down, and usually in a pit, if it is of large size, because the ways are heavier in section than the bottom flange. The heavy section is thus located at the bottom of the mold where it cools more slowly. In pouring the metal into the mold, which is gated at the bottom, the cooler iron rises to the top under the pressure of the hot incoming metal. The vees are therefore the last to solidify. Thus when the lathe bed is taken from the pit and set right side up on a level surface it will be found that the ends bow up in the case of a long lathe bed.

The amount that the ends are above the center may be from 1/2 to 3/4 inch in some cases, and in order to obtain a reasonably straight casting, it is necessary to "throw" the pattern in the mold in such a way that the mold, when poured, is bowed in the opposite direction from that assumed by the casting after it has been removed from the mold. It is not difficult to "throw" or change the pattern in the mold, as it is usually made in sections, and the sections may be readily changed the required amount by raising them with wooden wedges at the time the mold is rammed up.

Now let us assume that the ends of the casting will warp 1/2 inch, and that the pattern is divided into three equal sections. If the two end sections are wedged up 1/2 inch at the outer ends when the mold is rammed up, the casting will be straight.

Dealing with Shrinkage Strains

If the webs that form the sides of a lathe bed vary uniformly in temperature at the instant the final setting of the metal occurs, the casting will be free from shrinkage strains, even though the different parts shrink unequally. However, it is extremely difficult to so arrange the sections and the method of molding them that this result may be obtained, and consequently the metal in the flanges is naturally more or less strained when the casting becomes cold.

When the roughing cut is taken on the bottom of the casting, these strains are relieved and the casting tends to change its shape. If it is unclamped at this point and turned over and a roughing cut taken on the top, other strains will be relieved and the casting will again change its shape. If it is necessary that the bottom be an accurately planed surface, the casting must be turned over again and the bottom finish-planed after the rough-planed top has been carefully packed up on the planer table. If the work has been properly done and the casting is now turned back for finish-planing the top, the bottom should be flat on the planer table. The top may now be finish-planed without any subsequent change in the form due to the relief of shrinkage strains.

It is the opinion of many shop men that shrinkage strains are not relieved at once upon the removal of metal, but that the strains are relieved gradually and that a period of time is required for the metal to assume its final form. In so far as shrinkage strains are concerned, this is not true. When we consider the other two causes of change in the form of castings, namely, changes in temperature and changes in crystal form, we will see that the time element does sometimes play a part. However, in the matter of shrinkage strains, no delay in the machining of a part is required. It is only necessary to free the work from the effect of the clamps in order to permit it to assume its natural form and to support it properly by suitable packing and then finish-machine it in order to achieve the required results.

The Effect of Clamping and Shrinkage Strains

Many machinists who understand perfectly the effect of clamps and chucks in producing strains in the work while it is being machined forget, or do not understand, that when the shrinkage strains are relieved it is necessary to unclamp the work in order to allow it to assume its natural form. It may be reasoned that, since the work was not under clamping strains at the time it was set up, it is still free from strains after the cut has been taken. This is not true, however, for as soon as the shrinkage strains have been relieved, it becomes necessary to treat the work as though it were a new piece and reset it in the chuck or on the table of a planer or milling machine in such a way that the clamps do not subject it to strain after it has assumed its new form.

The usual procedure is to rough-machine the bottom of the lathe bed, then turn it over, level it on the planer table, and rough-machine the top. When the lathe bed is first turned over, the bottom will still be warm from the action of the roughing cutter. As the machining of the top progresses, the bottom of the casting becomes cool and the top becomes warm; consequently as the planing operation goes on the top surface becomes warped or, as often expressed, develops a "wind."

When the planing operation began, the top surface was bowed up at the ends due to the fact that it was cool while the bottom of the lathe bed was warm. As the bottom cooled and the top became warm from the effects of the planing operation, the center began to rise, and this change, coupled with that of the progressive movement of the tool across the work, left the surface low in the middle after the work again cooled.

Allowing Work to Cool Between Cuts

In order to plane the bed of a lathe in such a manner that it will not change its form, it is necessary, if the top has been rough-machined, to let the work cool to a uniform temperature before the second cut and the finishing cut are taken. Also the clamps must be released between cuts and the bed carefully releveled and reclamped. This has been mentioned in connection with the relieving of shrinkage strains, but even though no shrinkage strains are present, this precaution is still necessary in order to take care of changes in the form of a casting resulting from changes in temperature.

Not only must the effect of changes in temperature due to the machining process be considered, but we must also guard against changes of temperature resulting from variations in the temperature of the shop and radiation. If the temperature of the shop is rising during the process of machining, as often happens in Winter, the outside and the top of the casting will be warmer than the interior. Under these conditions, the bottom of the casting will bend, so that it will have a slightly different shape than it would have had if it had been kept at a uniform temperature.

If the shop is being heated rapidly, as sometimes happens on cool mornings, different parts of the casting may have a difference in temperature of 20 degrees which will, of course, result in changes in the form of the work. Internal ribs, which are cooler than the outside of the casting, will tend to distort the machine surface until it has a series of slightly curved sections. In such cases, considerable trouble will be experienced in scraping the surface when the casting is brought to the assembly floor, as there will be high points where the internal ribs join the flat surface after the casting has cooled to a uniform temperature.

A casting on which the sun shines or which is close to a steam pipe or upon which a blast of warm air blows will not be of uniform temperature throughout and will have a form during the process of machining which is different from that which it will have after it is cold. A casting that is not uniform in cross-section will not be of the same temperature throughout its length if it has been exposed to higher or lower temperatures previous to the machining operations. All these factors must be considered when very accurate work is required.

Seasoning and its relation to chemical and crystalline structure will be dealt with in a succeeding article. Other factors involved in the same general subject were discussed in the article "Why Machined Castings Change Shape" on page 905 of August MACHINERY.

* * *

ADVICE TO YOUNG SHOP MEN

The evening schools are intended for those who must work during the day. Make use of them and spend your evenings profitably. Get in touch with the local vocational school and see what courses are offered. Take up such studies as English or mathematics. Almost any course is well worth the time spent.—From the *Warner & Swasey Appentrice.*

Selecting Electric Heat-treating Equipment

Second of Two Articles Explaining Points to Consider in Planning Installations

By EDWIN FLEISCHMANN, Westinghouse Electric & Mfg. Co., Chicago, Ill.

ELECTRIC furnaces of the resistor type, commonly employed in heat-treating work at temperatures up to 1850 degrees F., were dealt with in the first of these articles, which was published in September MACHINERY. Specific information was given concerning the construction of the shell and its supporting frame, the door, the insulation, the refractory lining, the hearth, and the heating element supports. The present article will discuss heating elements, terminals, terminal connections, furnace voltage, and furnace control.

Facts Concerning the Heating Elements

Perhaps the least understood and, therefore, often the weakest parts of an electric furnace are the heating elements. For ordinary metallic resistor furnaces, the heating elements are made of nickel-chromium, having approximately from 80 to 85 per cent nickel and from 15 to 20 per cent chromium, with preferably no iron at all. This alloy melts at about 2600 degrees F., and is comparatively unaffected by use in air up to between 2000 and 2200 degrees F., when progressive oxidation becomes serious. It is important to make sure that the temperature of the elements will be well below these values under the most severe operating conditions. Hence, manufacturers normally rate their furnaces for operation up to temperatures of 1850 degrees F. in the furnace chamber. At higher temperatures, the life of the heating elements is appreciably decreased.

A word may be said at this point about furnaces for temperatures in excess of 1850 degrees F. These furnaces use carbon, or some compound of carbon, in the form of plates, rods, or granular material, as resistors. They are usually employed only where electric heat is absolutely required. The life of carbon elements is short under such severe service, often lasting only a week and seldom more than a month. If an electric furnace must be used for such work, the design should facilitate renewal of the elements as they give way. The carbon parts themselves are not very expensive.

The matter of easy element replacement is also a factor with metallic resistor furnaces, where, however, good design can make renewals infrequent. It is sometimes well to make the roof removable as a whole or in sections, so that the chamber will easily be accessible in case of need; but when this is done, it is important that the joint be simply and positively sealed against excessive heat losses. The furnace shown in Fig. 2 of the previous article may be dismantled in this way.

The nickel-chromium alloy for the elements may be of a number of cross-sections, either drawn or cast; but, in general, the simpler geometric shapes, as round rod or flat ribbon, are most popular and lend themselves readily to use in furnaces. Whatever cross-section is used, it is vital to keep in mind that all the heat generated in the elements must leave them, and that the only means of egress is through the surfaces. If excessive wattage is generated in a heating unit with too small a surface area, the temperature will rise until the heat is dissipated; there is no exception to this rule.

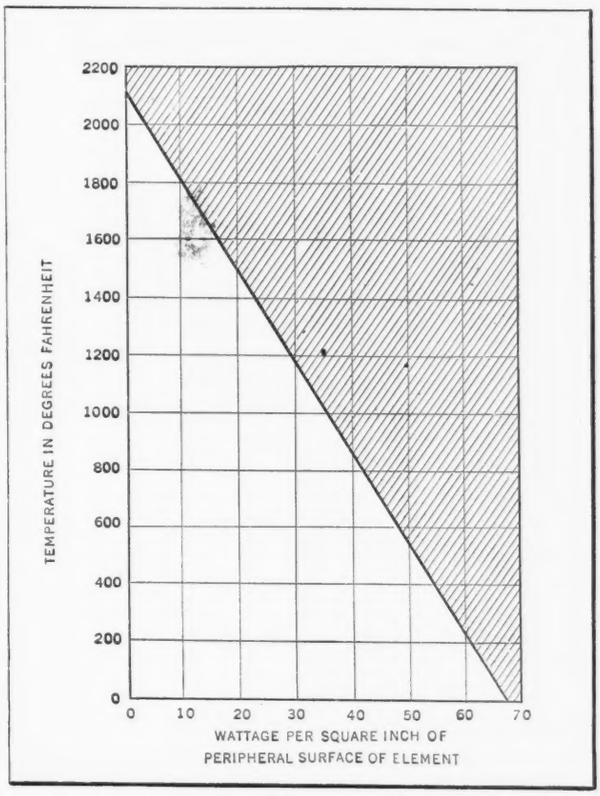


Fig. 8. Chart for Determining the Worth of Heating Element Designs

The chart shown in Fig. 8 may serve as a rough check in determining the worth of a heating element design. The ordinates represent temperatures in the furnace chamber, and the abscissae, the number of watts radiated from each square inch of the peripheral surface of the heating elements.

For a round rod,

$$\text{Watts per square inch} = \frac{26.53W}{DL}$$

For flat-ribbon or rectangular cross-sections,

$$\text{Watts per square inch} = \frac{41.67W}{(A + B)L}$$

For any other shape,

$$\text{Watts per square inch} = \frac{83.33W}{PL}$$

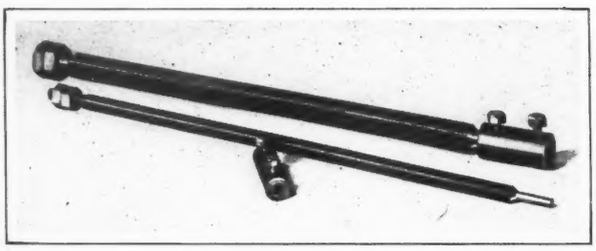


Fig. 9. How the Connector Shown in Fig. 10 is Used on Furnace Terminals

In these formulas,

W = total installed capacity of furnace, in kilowatts;
D = diameter of rod, in inches;
L = total length of heating elements, in feet;
A = width of ribbon, in inches;
B = thickness of ribbon, in inches; and
P = perimeter of resistor cross-section, in inches.

If the value obtained by means of one of these equations falls within the unshaded portion of the curve, the design is conservative and safe. Long life of the units may ordinarily be expected whenever they are used open and unmuffled in the furnace chamber and have no obstructions or heavy loads placed so close to them as to prevent liberation of their heat. If the value falls in the shaded area, the furnace should be carefully scrutinized, because it is likely that with high wattage ratings per square inch, the element temperature will be too near the oxidizing point, and short life will result. With properly rated heaters, a life of several years is not unusual.

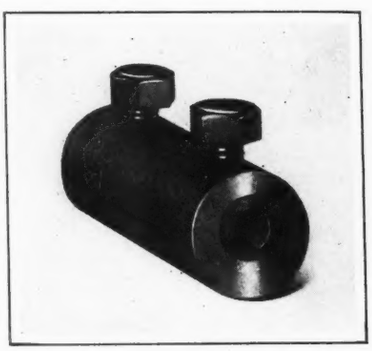


Fig. 10. Connector which Holds Firmly due to Oxidation

Too much stress cannot be laid upon the necessity for conservatism in rating heating units. Many factors limit the total radiation of the coils. For instance, the proximity of the turns to each other, the shape of the supports, the nearness to the charge, the shape and size of the charge—all vary the facility with which the heat can be dissipated, and, therefore, point the need of care in design. The curve shown in Fig. 8 takes into account the most adverse conditions of load with ordinary spacings of turns. (The effect of the proximity of adjacent turns on the rating of heating elements is referred to in "The Rating of Heating Elements for Electric Furnaces," by A. D. Keene and G. E. Luke, Journal of the American Institute of Electrical Engineers, Vol. XLV, March, 1926.)

Muffle plates increase the temperature gradient between the heating elements and the furnace chamber. When they are required, the elements must be rated very low, in watts per square inch, and a good thermal conductor used as a muffle. Perforations such as seen in Fig. 3 of the previous article also cut down the difference in temperature.

The distribution of the heating elements in the furnace chamber should be such as to insure the required temperature distribution. In large furnaces, this will depend upon the cycle of operations, and the arrangement and proportions of the charge. The same is true of small outfits; but here, it is an established fact that the heating of a given charge is greatly enhanced if the heat is applied from all sides at once. However, it is often either impossible or impracticable to mount heaters on both the sides, top, and bottom. In such cases, it is important to be sure that the radiation reaches the charge from as many angles as possible, either directly from the elements or by reradiation from the brickwork. The heaters themselves must be carefully designed to prevent overheating.

The heating elements should be of large cross-section in order to withstand heavy service. Longer life will always result from larger sections, since oxidation, even if it should begin, would make less progress proportionately than with fine wire. Sturdiness and avoidance of flimsy construction are the chief points to be considered. The limitation on the size of the resistor cross-section is the furnace voltage, and whenever large units can be connected in series to operate conservatively on line voltages, the expense of transformers may be avoided.

Terminals and Their Connections

Current must be supplied to the heating chamber through the walls, and interconnections of the elements must be accomplished either wholly within the furnace or outside of the walls, by means of jumpers. It is important to be sure that the terminals are of considerably enlarged section where they pass through the walls, so that the heat generated can be more readily dissipated. The terminals themselves are usually made of nickel-chromium.

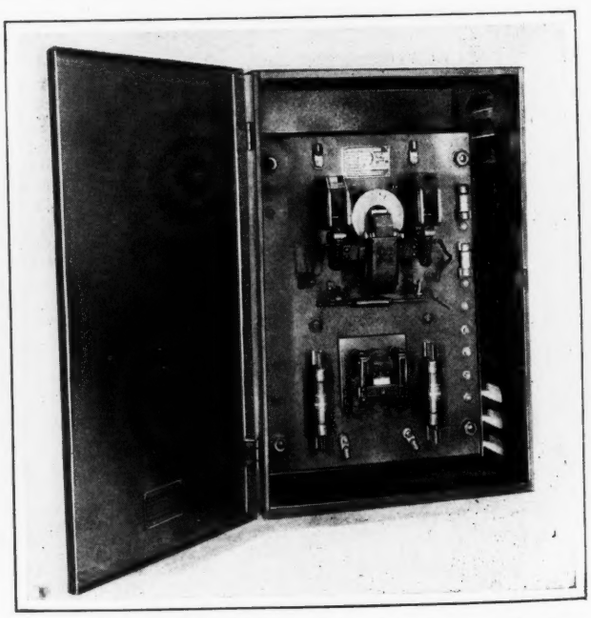


Fig. 11. Enclosed Type of Control Panel for Electric Furnace Service

Consideration should also be given to the locations where the terminals are brought out. They should be concentrated at one point for convenience, if possible. If this cannot be done, they should be brought out at easily accessible points and, in either case, they should be suitably covered and arranged for conduit connection.

The connection of terminals to the elements and the interconnection of the units themselves present similar problems. Welding is probably the usual connecting method when connections are made wholly within the heated enclosure. Nickel-chromium is welded with rod of the same material, using a gas torch, a hot flame with an excess of hydrogen being required. The only disadvantage of a good weld is that it must be cut to be renewed, and that process often destroys some of the heating element length.

Another means of connection inside the chamber is shown in Fig. 10. This connector consists of a nickel-chromium sleeve into which is pressed a cold-rolled steel tube, the inside diameter of which is very nearly the same as the outside diameter of the rods to be joined. Set-screws serve to hold the two rod ends firmly in position. It is a well-known fact that iron oxidizes destructively above about 700 degrees F. Therefore, at the first heating to elevated temperatures, the steel sleeve oxidizes, and, because the oxide occupies considerably more space than the original steel, the sleeve presses tightly against the heating element ends on the inside and the nickel-chromium sleeve on the outside.

This makes a firm joint having an electrical conductivity which is often better than that of a weld, because the oxide is under such high pressure. In renewing the joint, it is only necessary to saw the connector longitudinally on each side and remove it. The original heater rod length is preserved, and the connection can be re-established by means of a new connector. The method can be applied to connect elements to each other or to terminals of the type shown in Fig. 9.

Furnace Voltage and Control

Ordinarily, standard terminal voltages, such as 110 or 220, are preferred for furnace work, except for small units equipped with manual control. The reason is obvious; if the voltage required is not standard, transformers are necessary, and these increase the first cost considerably. Except in cases where the designer finds it impossible to use elements of substantial cross-section on standard voltages, unusual ones should be avoided.

Electric furnaces are controlled either by hand or automatically. Manual control equipment ordinarily consists of a rheostat or a transformer and tap-changing switch, whereby the input can be changed so as to equal the losses at any given temperature, approximately, or to give any desired speed of heating for a charge. An indicating pyrometer is also necessary. This is usually of the galvanometer or potentiometer type, actuated by a thermo-couple in the heated chamber.

For all except the simplest operations of laboratory proportions, automatic control of temperatures is essential, if the full benefits of electric heat are to be realized. The pyrometer may be either indicating or recording, of the electric contact type having within it three contact points—common, low, and high. The low and common contacts energize the furnace through relays. When the temperature has risen to the predetermined value, the high and common contacts touch and shut off the current. This cycle is repeated during the operation of a furnace; in this way, the temperature may be maintained within a few degrees of the desired setting.

Attention should be given to the contacts, because as they make and break the relay circuit frequently, they are subject to considerable wear. They are usually of tungsten, silver, or some arc-resisting alloy, and ought to have a quick make-and-break mechanism. When dust and dirt are prevalent, the pyrometer should be enclosed in a dustproof case. Automatic zero temperature compensation is important where work is done in a hot room. An auxiliary contact to shut off the furnace in case the main contacts fail is also of value.

The pyrometer is actuated by a thermo-couple located either in the furnace chamber or on the heating elements, or both, depending upon the service for which the furnace is used. When large masses are heated close to the elements, and excessive temperature is feared, dual control is best. By this means, with a two-point pyrometer, the element temperature and the furnace temperature are each checked at frequent intervals, and neither one is allowed to become excessive.

The pyrometer actuates a relay, which, in turn, operates main-line contactors. The control panel usually contains the contactors, relay, and fuses, as shown in Fig. 11. These parts may be obtained enclosed in a sheet-metal cabinet or open. Whenever they are to be used in shops where workmen can touch them, the enclosed type is recommended. A gold thermal protective fuse in the control circuit will prevent overheating of the furnace, and destruction of the lining and elements, should the pyrometer become inoperative. This fuse melts at about 1950 degrees F.

Summary

An electric furnace should have a sturdy framework that is proportioned to its work; good and sufficient insulation; carefully designed heating elements which are properly supported or connected; and reliable control of the operating temperature. The furnace should, in other words, be designed to do the job for which it is intended, taking into account all of the many factors that manufacturers and users generally accept as facilitating operation and repairs and tending toward long life. Many of the matters discussed have been general in nature and apply to practically all furnace installations.

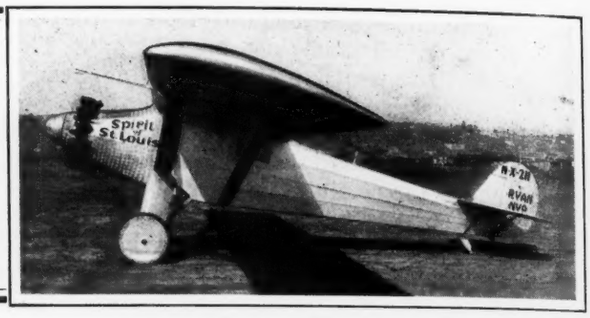
* * *

The mining and treatment of one of the world's most universal and essential metals is shown in an eight-reel educational motion picture film, "The Story of Copper," just completed by the Bureau of Mines, Department of Commerce, Washington, D. C., in cooperation with one of the large copper producing companies.

Building the Ryan Monoplane

Some of the Methods Employed in Building the Plane Used by Lindbergh

By JOHN HOMEWOOD



AT the time the *Spirit of St. Louis* was built, the Ryan Airlines, Inc., San Diego, Calif., now known as the B. F. Mahoney Aircraft Corporation, was building one plane every three weeks. The recent flight to Paris so conclusively proved the worth of this plane that production has been increased to two planes per week. The stock plane made at the time the Ryan NYP was in process has been greatly improved in design, but it is still passing through a stage of evolution.

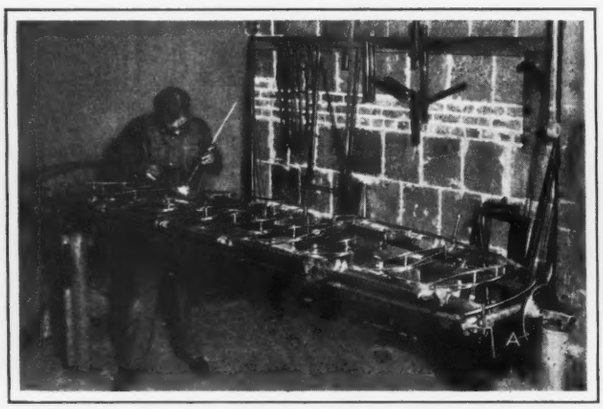


Fig. 1. Welding Joints on Aileron

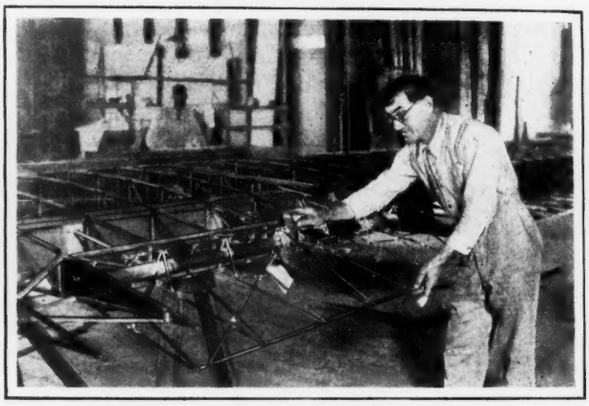


Fig. 2. Assembling Aileron to the Wing

Under these conditions, the mode of manufacture must be flexible and, while not on an ideal production basis, the work is carried out with the predominating thought of obtaining quality. Tubing, rods, blanks, and various parts manufactured elsewhere are kept in stock. Assembling fixtures that can be quickly and inexpensively constructed facilitate the assembling and welding operations on the various parts. In Fig. 5 is shown the assembling frame for a section of the fuselage, the horizontal tubes being located by the guides shown, and the various pieces arranged in their proper order prior to welding. The complete assembly of the fuselage skeleton, acetylene welded throughout, is shown in Fig. 6. The assembling and welding fixture, Fig. 1, for the aileron and tail surfaces consists of bearings supported at the tops of two uprights. The holder for the parts rotates on trunnions, and is located in any convenient position by inserting a pin in the disk *A*. The wing rib is assembled in the fixture shown in Fig. 3. The various wooden pieces are located by pins, and after being assembled, the complete rib is elevated or lifted from the guide pins by push-pins operated by a foot-treadle.

The fixture for assembling the wing arch is shown in Fig. 7, and is similar to the one used in assembling the aileron and the tail surfaces. In this fixture, the wing arch straddles the holder, which consists of an I-beam upon which are welded trunnions. The trunnions permit the fixture to be located or turned into any desired position. The

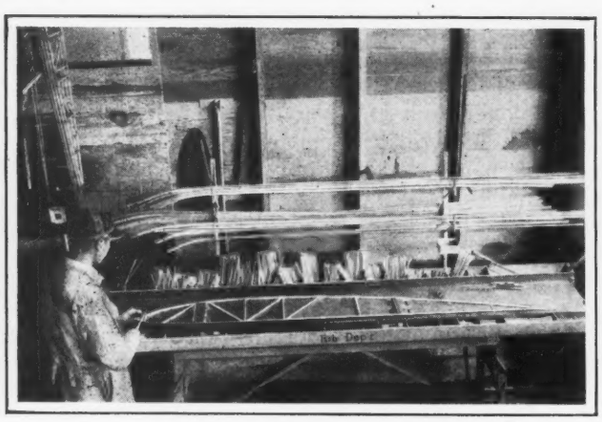


Fig. 3. Assembling Wing Rib

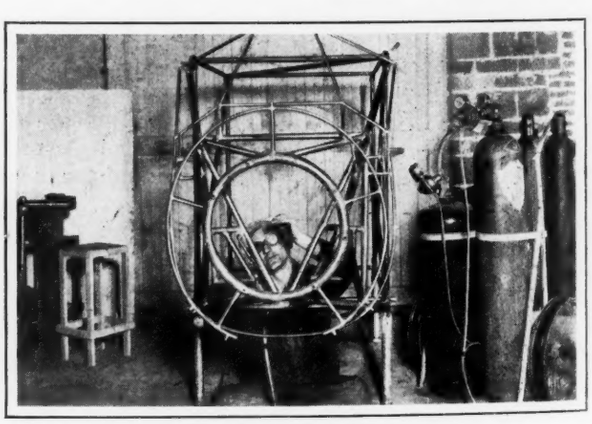


Fig. 4. Constructing the Engine Mount

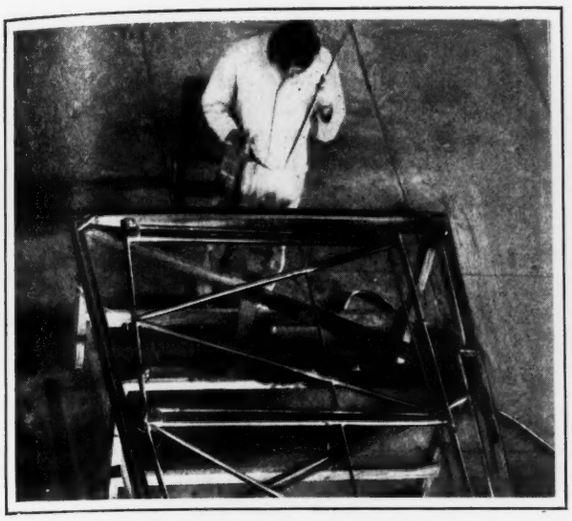


Fig. 5. Welding Joints of Fuselage Frame

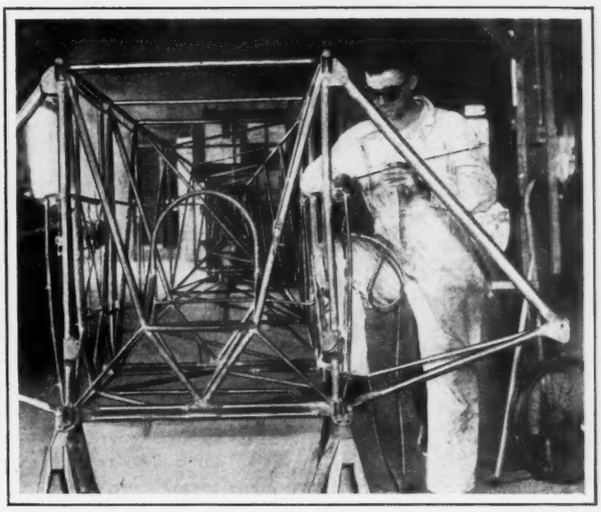


Fig. 6. Front View of Fuselage Skeleton

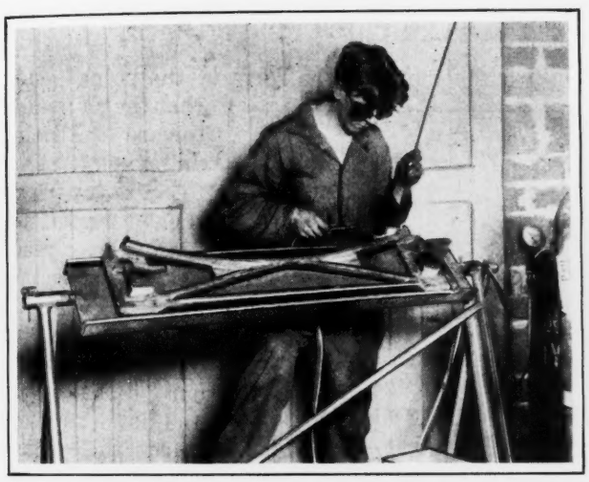


Fig. 7. Assembling the Wing Arch

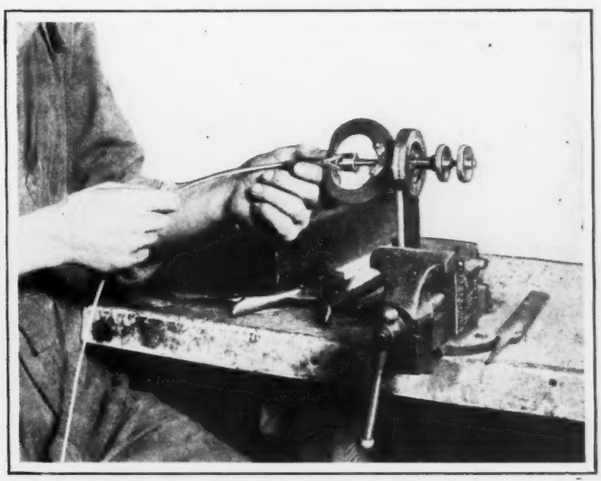


Fig. 8. Assembling and Splicing Guide Cable to Eye

Fig. 9. Covering the Wing Frame

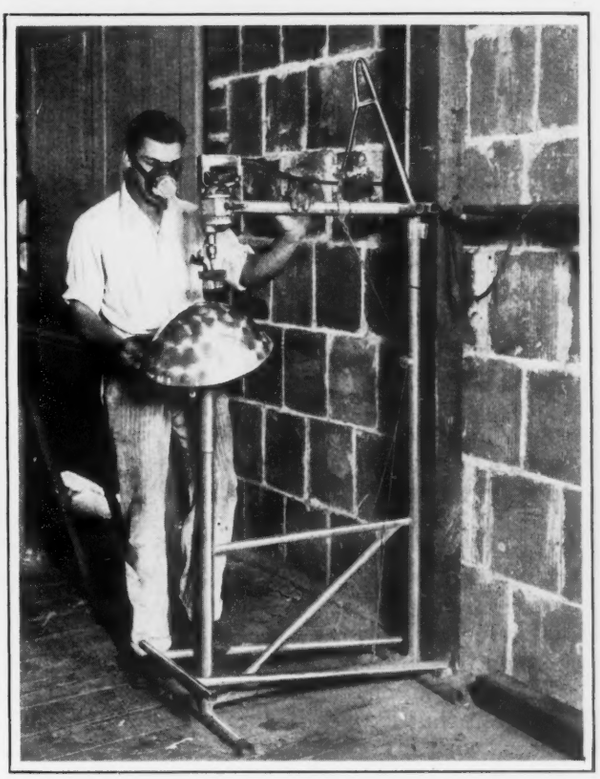


Fig. 10. Finishing the Nose-piece

fixture shown in Fig. 8 for assembling and splicing the guide cables to the cable eye, which is held in a vise, consists of a claw and thrust piece operated by a screw. This fixture enables the cable to be gripped tightly to the eye leaving ample room for splicing.

The wing frames are covered with mercerized cotton cloth (see Fig. 9) which is coated with nitro-cellulose. This coating shrinks the cloth and renders it waterproof. In Fig. 10 a workman is shown applying the "Lindy" finish to the nose-piece. This is accomplished by a wire brush, rotated rapidly by a small electric end drill mounted on an arm that can be pulled down into contact with the work by a foot-treadle.

* * *

TAP DESIGN AND CONSTRUCTION

By E. J. BRYANT, Tap and Gage Engineer, Greenfield Tap & Die Corporation, Greenfield, Mass.

I have been following with interest the series of articles entitled "Design and Construction of Taps," by Mr. Valentine, which have been appearing in MACHINERY, and feel that two statements made in his August article require further comment, since in my judgment they are open to misinterpretation.

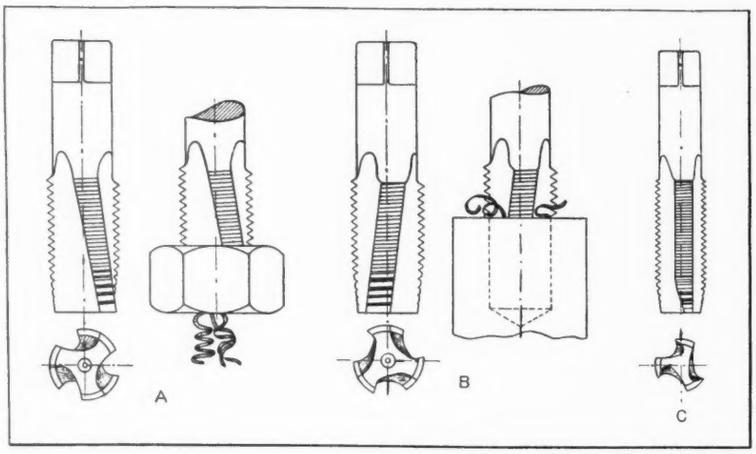
First, I find the following statement: "It is conceded that the *ordinary* gun tap, as well as those shown at *A* and *B*, do not produce as fine and smooth a thread as ground spiral-fluted taps with a less marked angle of spiral." The italics are mine, but they indicate that Mr. Valentine has compared ordinary (cut-thread) taps of one design with ground-thread taps of a different design. Gun taps manufactured by the Greenfield Tap & Die Corporation and gun type taps made by other manufacturers are available with ground threads, and for the ground-thread gun tap we can say that it produces as fine and smooth a thread as any other type of ground-thread tap on the class of work for which it is designed—production tapping of through holes in tough or stringy materials.

Further, Mr. Valentine in discussing gun tap design overlooks the real reason why properly designed gun taps cut unusually smooth threads—so smooth indeed, that it is not too much to say that under certain conditions a cut-thread gun tap will produce as good a thread as a ground-thread tap of other design. This is because gun taps, when operating in material that is sufficiently tough for the chips not to crumble, impart a curling action to the chip that carries it ahead of the tap point, whereas, with other types, the chip is curled directly back into the thread and exerts a scratching and tearing action on the thread walls just cut.

The second statement made by Mr. Valentine which I find open to misinterpretation is as follows: "The tap shown at *A* has an advantage over that shown at *C* in that it is easier and cheaper to sharpen correctly; and when sharpening, the correct flute form, cutting angle, and rake are easily maintained. Taps such as shown at *B*, for bottoming holes, tend to pull the chips upward toward the shank, like a twist drill, and hence, the chances of the tap breaking, because of the chips clogging in the flutes or collecting in the bottom of the hole, are materially reduced."

For clarity Mr. Valentine's drawings are reproduced (see illustration). So far as is at present known, the spiral-fluted tap in the smaller sizes that are used in greatest quantities cannot be made with sufficient angle of spiral and sufficient slope at the bottom of the flute to produce a curling action of the chip great enough to cause the end of the chip to clear the side walls and the minor diameter of the thread and curl forward ahead of the tap.

With the gun tap, the form of the point is such that the chip starts toward the point, and when it begins to curl up from the bottom of the flute, it has already passed the minor diameter and the side walls of its own thread without touching it, and is headed toward the open space at the end of the tap. It comes out in chips, as shown in the author's sketch—a form of chip which the spiral-fluted tap illustrated will *not* produce except in large sizes which can be made with steep spiral flutes.



Special Taps for Threading Through and Bottoming Holes

An inexperienced person can probably sharpen a spiral-fluted tap more easily than a gun tap, but most of the difficulty in sharpening a gun tap is easily overcome by comparing it with a model tap when grinding; in this way, the gun tap point is easily maintained. The gun tap is essentially a machine tap and is intended solely for production tapping. Under American methods of manufacturing, such tools usually come under the supervision of experienced tool men, who have no difficulty, as far as our observation goes, in keeping them at maximum efficiency.

In any comparison between gun and spiral-fluted taps, it should also be recognized that gun taps can be manufactured with very shallow flutes, and consequent additional strength, since the flutes are not required for chip passage. Gun taps, because of their correct cutting angle, are also economical in power consumption—a fact easily demonstrated without testing machines by comparing gun type taps and ordinary hand taps in portable electric tappers, the hole capacity of which is materially increased when gun taps are used.

Notes and Comment on Engineering Topics

During the past year, more than 40,000 passengers were carried on the various lines of the Luft Hansa, the company that controls the German airplane service. The system has been so organized that local air lines act as feeders to the through international lines, there being junction points at stated intervals, much the same as in railway service.

An investigation conducted by the Society for the Promotion of Engineering Education indicates that one of the most immediate needs in technical education is the establishment of schools that will provide for a briefer, more practical, and more intensive training than that of an engineering college, and at the same time give a broader training than can be obtained at a trade school.

The extent of the routes regularly covered by commercial bus lines now exceeds the railways in mileage. There are in the United States 257,000 miles of railways, while at the present time 270,000 miles of road are covered by regularly operating bus lines. About 33,000 buses are engaged in rendering service over these routes and last year 2,100,000,000 passengers were carried. The total investment in rolling stock, terminals, garages, etc., for these bus lines is estimated at $455,000,000. In addition to the commercial buses in use, over 30,000 buses are engaged in transporting school children back and forth between home and school.

According to a compilation made by the Bureau of Foreign and Domestic Commerce, Washington, D. C., there were at the beginning of this year approximately 1,725,000 motorcycles in use throughout the world. Contrary to the trend during recent years in the United States, the motorcycle as a transportation means is being utilized to an ever-increasing extent in many foreign countries. The United Kingdom has the largest number of motorcycles in use, followed by Germany, France, and the United States. The world's production of motorcycles is estimated at about 350,000 a year, of which only 42,000 are made in the United States—about 13 per cent of the world's total.

According to an article in *Engineering*, of the ocean-going vessels now being constructed in Great Britain, 203, with a tonnage of about 760,000, are steamships, while 98, with a tonnage of 628,000 are motor ships. Of those constructed in other countries, 167 are steamships, with a tonnage of 609,000, and 170 are motor ships with a tonnage of 831,000. Thus, of all the ocean-going ship tonnage now being constructed in the world there is a larger tonnage built for internal combustion engine drive than for steam drive. The present report is the first one of Lloyd's returns to show a greater tonnage of motor ships being built than of steamships. Vessels of less than 100 gross tons are not included.

An amazing story of sheet steel as transparent as the clearest glass comes from Germany. It is stated to be the invention of Dr. Carl Mueller who is connected with the Physical Technical Institute of Berlin. These sheets are made by the electrodeposition of a fine film of metal on a smooth surface; the film being subsequently separated from its foundation. It is said that these thin films of transparent metal permit ordinary photographs to be taken right through them. Although these metal sheets are so thin that light rays will penetrate them, it is stated that when fastened in a frame, they are strong enough to be bent to the extent of 1/16 inch without breaking, by merely blowing against them.

A 10-ton 60-foot span electric overhead traveling crane put together entirely by means of arc welding has been built by the Cleveland Crane & Engineering Co., Wickliffe, Ohio. Each girder of the crane is of the fish-belly box type, consisting of two webs with top and bottom cover plates. The end trucks, completely arc-welded, are of box section with stiffening diaphragms. It is in the trolley itself that the greatest advantages of arc-welded construction have been realized. Here considerable weight is saved and greater rigidity and strength is obtained. The greater rigidity insures permanent positive alignment of all shafts and bearings. The company's engineers claim that tests have amply justified their faith in arc-welded crane construction.

The Milwaukee Electric Railway & Light Co. has installed a steam turbine generator that uses steam at a pressure of 1200 pounds per square inch superheated to 720 degrees F. It exhausts at 320 pounds pressure, the steam being conducted at this pressure to the station mains serving several other generating units, where more of its energy is extracted. Final exhaust is at one inch absolute pressure. This pressure of 1200 pounds is between three and four times the average pressure of generating plants, and, with one exception, double the pressure in use in any station. The one exception is the 3000-kilowatt turbine generator in the Edgar station of the Edison Electric Illuminating Co. of Boston, which also operates at 1200 pounds pressure. The Milwaukee machine sets a record, however, in that it has a capacity of 7000 kilowatts—more than twice that of the Edison unit. Both units are of General Electric design and manufacture. A pressure of 400 pounds per square inch is now common in central stations, with some operating above this figure, but 600 pounds is believed to be the maximum except in the two cases mentioned.

Milling Fixtures for Hard Rubber

By B. J. STERN

THE milling fixtures shown in Figs. 2 and 3, which are of rather unusual design, are employed in machining a hard rubber disk. The first operation on the disk (see Fig. 1) is cutting a slot having an included angle of 15 degrees. The second operation consists of milling the bottom of the slot to the required radius *R*. Radius *R* is struck from the center of the disk, and must be held within very close limits. Previous to machining the slot, the disk is finish-turned to the correct outside diameter and thickness, and the center hole reamed to size.

Machining Angular Slot

Two cuts are taken to form the angular sides of the slot in the hard rubber disk. In Fig. 2 is shown the milling fixture used in taking these cuts. The base *A* of the fixture is keyed and clamped to the table of the milling machine, and contains the snugly fitted shank *B* of the work-plate *C*, which is free to revolve on the base and is held in place by the washer *D* and screw *E*.

The work *W*, shown by dot-and-dash lines, is placed on plate *C* where it is located by the pin *F*, which is a close fit in the center hole previously machined in the disk. The clamping plate *G* is used to hold the disk down on plate *C* while the slot is being cut. The clamping pressure is provided by two stiff springs *H*, which are so placed on studs *J* that they exert pressure against the base *A*, which pushes down the nuts *K* on studs *J*. This action, in turn, transmits pressure to the clamping plate. The clamping plate *G* and work-plate *C* are forced apart to permit locating the work by means of the yoke *L*, which pivots on pin *M* in the work-plate *C*. Yoke *L* has two faces *N* at its extreme ends, which bear against the clamping plate. The handle *P* on the yoke gives the operator the necessary leverage for separating the plates. The yoke also serves another purpose—that of positioning the work for cutting the sides of the slot. Plug *Q* is secured to base *A* in the correct relation to the center of the disk. There are two angular slots in plug *Q* which provide the necessary locating points for the swinging disk.

When the yoke is swung around, it carries the work-plate and the work around until plug *R* in the yoke drops into one of the angular slots in plug *Q*, thus positioning the disk for the first cut. After the first cut is taken, the yoke is depressed until the plug clears the slot. The work is then swung around until the plug drops into place in the second slot, after which the second cut is taken. To remove the work, the yoke handle is pushed down in order to bring the yoke faces against the clamping plate and raise the latter member until the work can be taken out. The pins *S* in the yoke act as ejectors, pushing the disk up as the yoke comes up. After the work has been removed, another disk is slipped into place over the locating pin, the pressure on the yoke handle is relaxed, and the clamping plate is then forced down against the disk by the springs.

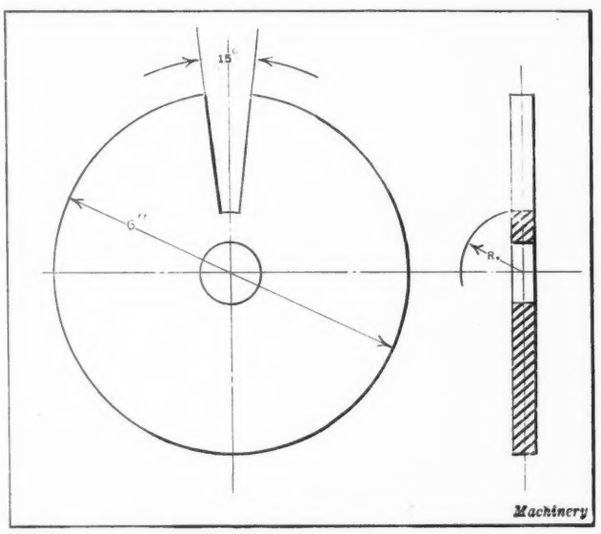


Fig. 1. Hard Rubber Part to be Machined

Forming Contour at Bottom of Slot

After the slot has been cut, the contour is formed to the radius *R*, Fig. 1, on the fixture shown in Fig. 3. From Fig. 1 it is evident that the entire disk must be swung on its center against a properly placed form cutter in order to machine the work to the required radius. The disk is slipped into place over the hardened and ground plate *A*, Fig. 3, so that the pin *B* will locate the work by the center hole and the pins *C* will bear against the angular sides of the disk slot, thus locating the slot correctly for the forming operation. The plate *A* is secured to the flat plate *Z* by screws and dowels. Plate *Z* has a round shank *E* turned on its opposite end, which is so positioned that a center line through the round shank will pass through the center of the work. The round shank is a running fit in the split bearing *F* of the base *G*, which is keyed and clamped to the table of the milling machine. The collar *H* is secured to shank *E* at the end of the bearing by means of set-screws. It is evident that the turning of collar *H* by handle *J* will cause the entire forging *D* to rotate with the plate *A*. The work is then rotated on its center in the position required for milling the slot to the radius *R*, Fig. 1.

Spring-actuated Clamp

The stud *K*, Fig. 3, is used to clamp the work in place while the cutter is in operation. Stud *K* is driven into a cold-rolled steel strip *L*, which is

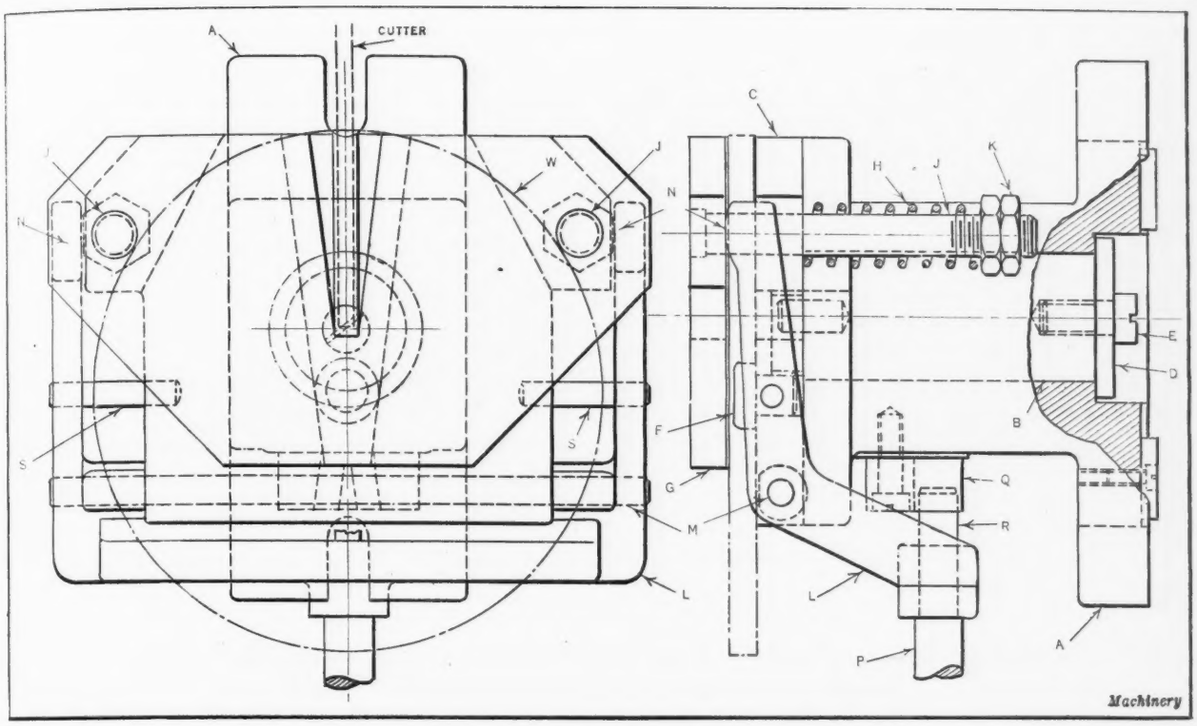


Fig. 2. Fixture Used in Milling Slot in Part Shown in Fig. 1

pivoted at one end on the shoulder screw *M* in the base *G*. Stud *K* projects over the disk, and when the disk is revolved, it is forced against the stud, thus providing a clamping action directly in line with the cutting point. In order to provide the necessary clamping pressure, a stud *N* is screwed into the forging *D* at a point which will allow the stud to pass through an elongated hole in the swinging clamp strip *L*.

A powerful spring *P* exerts pressure between the check-nuts on the end of stud *N* and the clamping strip *L*. This action forces the strip against the stop-pin *O*, which is driven into the base *G*. When the forging *D* is revolved, it carries the disk against the clamping stud *K* and forces the clamp strip *L* away from the pin *O*, thus permitting the full pressure of the spring to bear against the disk while the cut is being taken. When the disk is revolved back from the cutter, the clamping strip is stopped by a pin, which compresses the spring and releases the work, so that it can be removed.

In order to assist in the removal of the work, an ejector is placed under the disk. The ejector is designed to operate automatically. In forging *D* is a bearing slot *Q* in which the steel strip *R* is pivoted. This strip carries a block *S*, so placed that the two ejector pins *T*, which project from the block, will pass through plates *A* and *Z* and bear directly against the disk. The bolt *U* is screwed into the revolving forging *D*, so that the ejector strip will be held rigidly against the head of the bolt by the action of the stiff spring *V*. This construction makes the ejector mechanism practically a part of the revolving forging *D*.

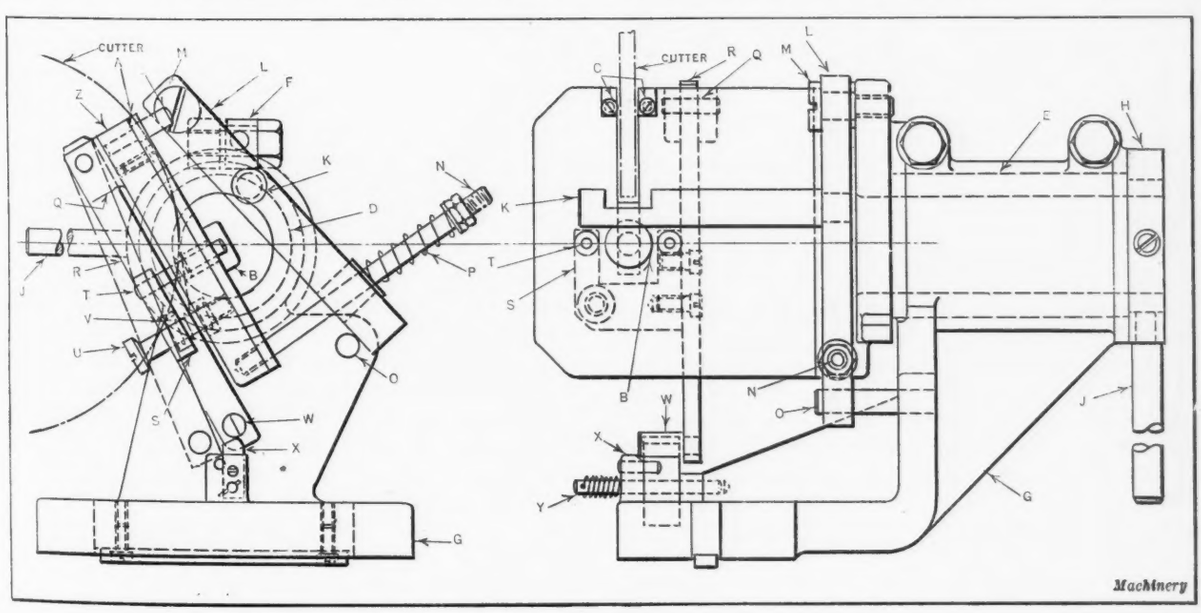


Fig. 3. Fixture Employed in Milling Radius at Bottom of Slot in Part Shown in Fig. 1

While the disk is being rotated for the cut, the pin *W* at the end of the ejector strip revolves about the center of the forging *D* and, at a given point, strikes the dog *X*, which fits in a slot in the base of the casting *G*. This causes the dog to rotate on the pivot pin *Y* against the action of a spring wound about it. When the end pin *W* has traveled a certain distance, the dog *X* is released, so that it flies back against the stop-pin. When the work has been cut to the required contour, and the disk rotated back, the pin *W*, still following its path about the center of the fixture, strikes the dog, and being unable to move it, causes the ejector strip and pins to stop against the revolving disk and, in this manner, forces the ejector pins to rise above the surface of plate *A* against the work, raising it far enough to clear the locating pin, so that it can be readily removed from the fixture.

In the meantime, the spring *V* is compressed, allowing the ejector strip *R* to move about its own pivot, independently of the fixture center, and thus permitting the pin *W* to follow a new path on a radius from the ejector strip center at *Q*. In following this new path, pin *W* reaches the point where it slips off the top of the dog at the instant the disk is freed from the locating pin on plate *A*. The compressed spring *V*, now being free to act, forces the ejector strip back until it strikes the head of the screw *U*, at which point the ejector pins are fully withdrawn from the surface plate *A*. The fixture is then ready to receive a new piece of work.

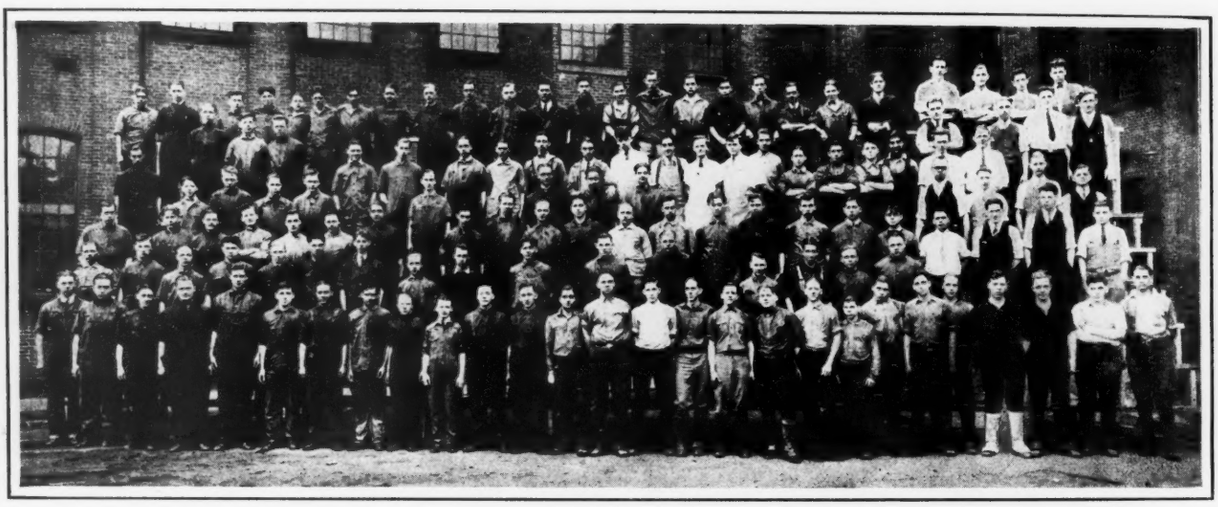
* * *

Coal mines, steel mills, and industrial plants are adopting a new red protective paint developed by the General Electric Co. for use with direct-current motors which are subject to acids, alkalies, oil, or dust. This paint is used effectively on the ends of the commutators and between the ends of the commutator bars and comb, to prevent the entrance of oil, moisture, carbon, and copper dust. Some companies, upon installing a new commutator, apply a coat of this new paint to the section where the V-rings fit in. The new comb rings are then installed, and the insulated parts of the commutator are painted with the paint.

TRAINING APPRENTICES ON A LARGE SCALE

In these days when so much is said about the need for apprentice training, it is of considerable interest to note that there are a number of large manufacturing concerns that are systematically training boys to become skilled in their trade and giving them a mechanical education that will fit them to take their places in industry. Among these is the Brown & Sharpe Mfg. Co., Providence, R. I. This company maintains one of the oldest and largest apprentice schools in the country. Young men are trained in the trades of machinist, draftsman, patternmaker, molder, coremaker, and blacksmith.

Besides the regular training in the production shops, each apprentice is given a thorough course in mathematics and mechanical drawing, during shop time, in a building set aside for class-room use. For senior boys there is a six months course in foremanship, covering such subjects as handling men, importance of production, overhead, and transportation of work.



Apprentices at the Brown & Sharpe Mfg. Co.'s Shops in Providence

In addition to the regular class work in mathematics and drawing, there are illustrated lectures by practical men on such subjects as cutting oils, grinding wheels, hardening, and testing materials. These lectures, as in the case of all class work, are given on company time, and the apprentices are paid their regular hourly rates. In each course a schedule of operations is carried out by means of charts kept by the apprentice department office. Boys do not shift for themselves. Instead, they are moved from one department to another with as much regularity as would be found in a high-school or college program.

There are 135 apprentices now taking the various courses; 47 of them come from outside of Providence and its surrounding towns. The homes of these 47 boys range from Illinois to Maine; most of them live at a dormitory maintained by the company exclusively for the apprentices. For ninety-four years the Brown & Sharpe organization and its immediate predecessors have trained young men in their shops. Such training benefit not only the company undertaking it, but the entire industry.

Sine Bar Indexing Device for Segment Gear

By PHILIP F. SHAFRAN

THE method of indexing by angular measurement, described in this article, was devised by the writer after the regular indexing equipment had failed to give the accuracy required in cutting a segment gear and a pinion for a model of a new machine. Referring to Fig. 1, *A* is the segment blank in which the teeth are to be cut, and *B* a cold-rolled steel block upon which blank *A* is fastened by means of two small clamps (not shown in the illustration). The block *B* takes the thrust of the gear tooth cutter and supports the brass blank segment *A*, which is only 3/32 inch thick.

The bar *C* is a piece of cold-rolled steel, 1 inch by 1/2 inch thick, which is securely fastened to block *B*, as shown. At *D* is a toolmaker's button which is fastened to bar *C* exactly 10 inches from the center of segment *A*. At *E* is an ordinary mandrel on which block *B* and segment *A* are mounted. In order to simplify the description of the method involved, let it be assumed that the blank to be cut is a 60-degree segment of a 180-tooth, 32-pitch gear.

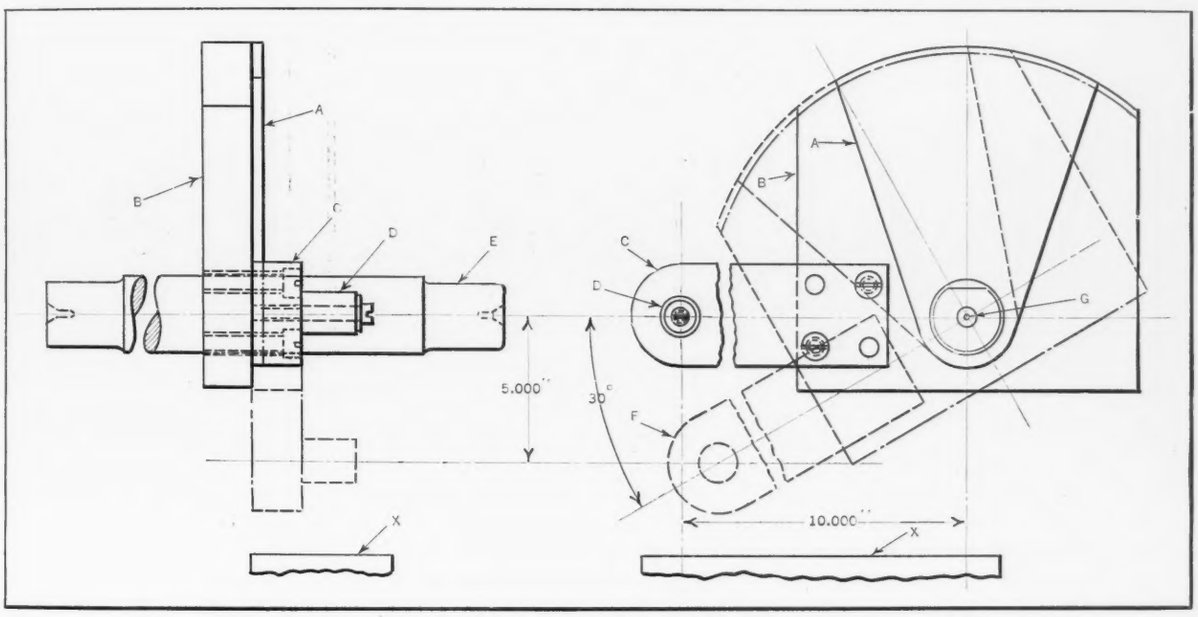


Fig. 1. Diagram of Sine Bar Indexing Arrangement for Segment Gear

Arbor *E* is mounted on the centers of the dividing head in the usual manner, with button *D* located in a central position relative to arbor *E*. A long parallel bar *X* is strapped to the table of the milling machine, to facilitate taking measurements over button *D*. The dividing head is first indexed 30 degrees to bring the fixture into the position shown by the dotted lines at *F*. One corner of the segment *A* is now on the vertical center line where the first space is to be cut.

As the segment of a 180-tooth gear is to be cut, the teeth must be spaced 2 degrees apart. A 60-degree segment, therefore, contains 30 teeth, and as half of the segment is cut with the bar *C* above the horizontal center line and half of it below this line, it is only necessary to make calculations for 15 teeth or a segment of 30 degrees. As button *D* is 10.000 inches from center *G*, it is a simple matter to calculate, by trigonometry, the exact change required in the height of button *D* above surface *X* to give an indexing movement equivalent to 2 degrees at any point 30 degrees above or below the horizontal center line.

In cutting the first space, button *D* is located 5.000 inches below the center of the arbor. This setting is carefully checked by means of a sensitive indicator and accurate size blocks. Assuming that the distance between the center of the arbor and the parallel bar *X* is 6.000 inches, the first measurement is 1.000 inch from the center of the button *D* to the surface of bar *X*.

It is understood that readings are taken over the top of the button and that one-half the diameter of the button should be added to the measurement. Thus, when a button 0.400 inch is used, the first reading over the top of button *D* will be 1.200 inches. Before proceeding with the spacing, it is well to set down all the measurements that are to be taken over the top of button *D*. These measurements can, of course, be readily calculated by ordinary trigonometry.

At fifteen spaces, the center of button *D* would be in line with the center of arbor *E*, and after this position has been reached, the measurements are taken above the center line. The amounts added for each indexing movement above the center line are the same as those subtracted from the height of the center line when indexing below the center line. By measuring 30 degrees on each side of the center line, a finer degree of accuracy is obtainable

than would be possible if the fixture were indexed 60 degrees in one direction, and only half as many calculations are required.

The spaces are all roughly indexed by means of the dividing head, and then carefully corrected to the fourth decimal place by means of the sine bar arrangement and the accurate size blocks and indicator. Adjustments are made by the usual means provided on the index-head. As the distance of button *D* is more than three times as great as the radius of the segment, the spacing of the segment should be correspondingly more accurate than the measurements taken over button *D*.

In Fig. 2 is shown a fixture used in cutting the teeth in the pinion gear. The method of indexing this fixture is the same as that used for the segment gear. In this case, however, it is necessary to index the fixture through 360 degrees.

Referring to Fig. 2, *A* is the gear blank on which twenty-four teeth of 32 pitch are to be cut. At *B* is a cold-rolled steel plate, about 7 inches in diameter, on which are fastened three toolmaker's buttons *C*, *D*, and *E*. The centers of these buttons are located 3 inches from the center of the plate and 120 degrees apart. Plate *B* is securely fastened to the arbor *F* on which blank *A* is mounted.

The arbor is set up on the milling machine in the position shown, with button *D* 1.500 inches, or 30 degrees, below the center of arbor *F*, and the first space is cut. In a 24-tooth gear, the teeth are spaced 15 degrees apart so that the next space cut would bring button *D* 15 degrees higher, or 15 degrees below the center, and the third cut would bring the button to the center line. Two more spaces are next cut, which brings button *C* 1.500 inches, or 30 degrees, above the center, as shown by the dotted circle *c*. The buttons *C*, *D*, and *E* will now occupy the positions shown at *c*, *d*, and *e*.

The indexing is continued, taking measurements over the button *C*, which is now 30 degrees above the center line. When button *C* has reached the position 30 degrees below the center line, the measurements are taken over the button *E*. The indexing is continued as described, until all the teeth have been cut. As the distance between the center of arbor *F* and button *C* is 3 inches, and the pitch radius of the gear is 3/8 inch, the accuracy of the gear tooth spacing should be correspondingly greater than the spacing of the buttons. The method of indexing described serves to check the spacing by direct measurement, and the accuracy obtained depends only on the care with which the buttons are located and the measurements taken. Gears having prime numbers of teeth that cannot be readily spaced by the dividing head can easily be cut by the method described.

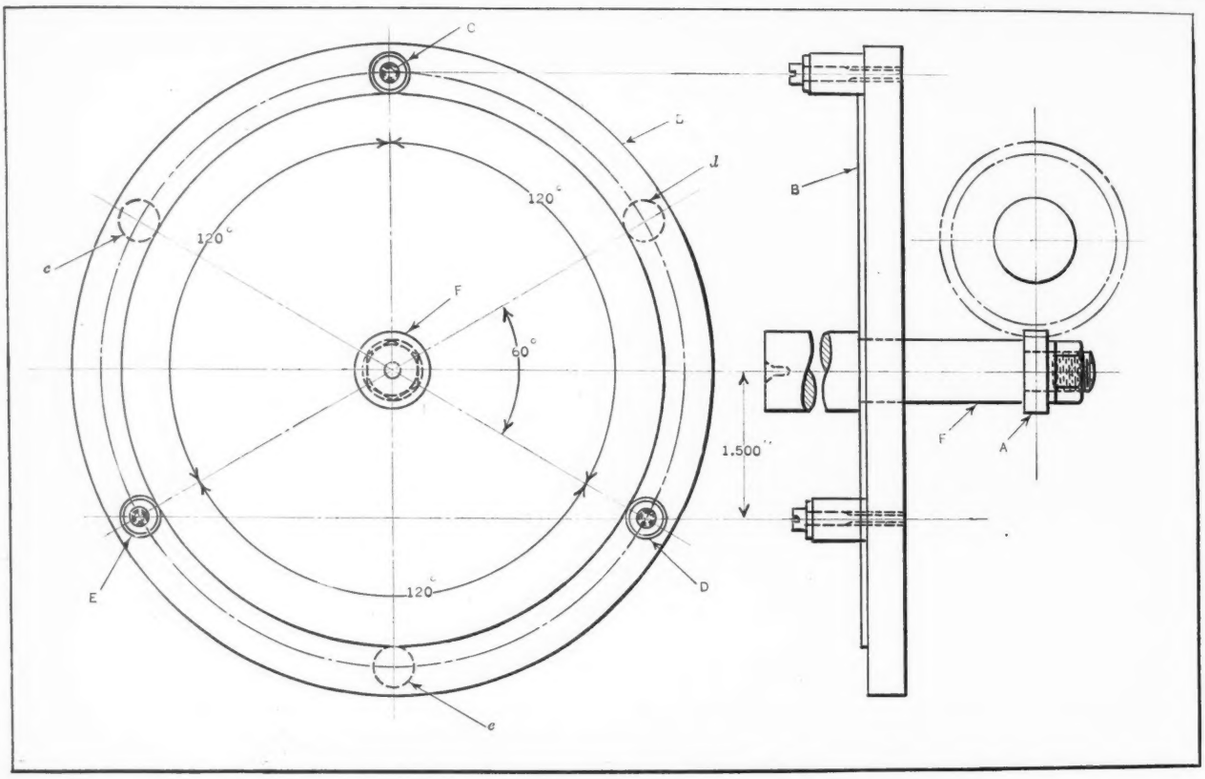


Fig. 2. Sine Bar Indexing Principle as Employed in Cutting Pinion

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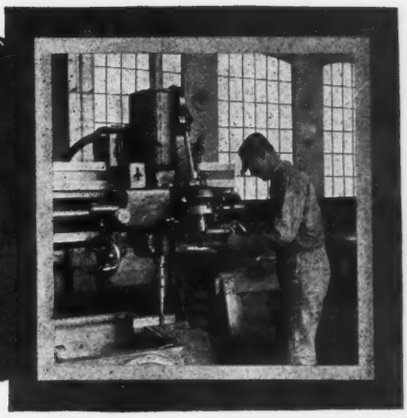
WESTINGHOUSE AWARDS SCHOLARSHIPS

Two Pittsburg and two New York young men received awards in the 1927 War Memorial Scholarships of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The scholarships, established in memory of the Westinghouse employes who lost their lives in the World War, consist of $500 a year for four years. The winners are H. L. Bunker, Jr., son of H. L. Bunker, a rate setter at the Westinghouse Works, who will attend the Carnegie Institute of Technology; P. G. Glaister, a tester at the same works, who will attend Cornell University; M. T. Ayres, son of M. C. Ayres, foreman at the Westinghouse Newark Works, who will attend the Massachusetts Institute of Technology; and A. L. Kime, son of R. R. Kime, a salesman of the Westinghouse New York office. Mr. Kime will attend Princeton University.

Letters on Practical Subjects



MACHINING SMALL SHOP TRUCK AXLE BRACKETS

The cast-iron bearing brackets shown at *A* in the accompanying illustrations are used in the construction of a small shop truck. In order to keep the total cost of the truck at a figure that will enable the manufacturers to compete on an even footing with other concerns, it is necessary that economical methods of machining be employed for such parts as the axle bracket. The hole in the bracket for the axle bearing is bored out on a drill press, using the holding fixture shown in Figs. 1 and 2. The rough bearing is placed as shown at *A*, Fig. 1, the drilled hole at *B* being located over a pin set in the stationary jaw of the fixture. This hole is first drilled in a small locating jig, and is also used as a locating point for the planing operation.

The holes at *C* and *D* are cored out and are not drilled at all, as they are merely required to permit the ends of the rough U-bolts to pass through. The bore of the bearing has two diameters, the larger part of the bore extending a little over three-fourths of the length of the hub, leaving a smaller hole at the outer end of the bearing. After a bracket has been placed in the fixture, the forked clamp is pushed in and the latch *E* dropped down in back of a shoulder *F* on the clamping screw. The clamping screw is then tightened by turning the ball-crank *G*.

The action of the slide and the screw will be better understood by referring to Fig. 2, where the various parts are indicated by the same reference letters as in Fig. 1. The fixture is shown in Fig. 2 with the work removed and the boring tool in its working position, the pilot being inserted in the guide bushing of the fixture. The clamping fork is carried in a sliding sleeve, flattened as shown at *H*, in order to keep it from turning. Back of the clamping fork and in the bore of the sleeve is a screw operated by the ball-crank. Thus the fork is run in or out, according to the direction in which the crank is turned.

The construction of the clamping device is such that the piece can be quickly and easily removed, and yet it is held solidly in place by the pressure exerted by the clamping screw. If the screw alone were used, it would be a tedious operation to run it back far enough to permit the work to be inserted or removed. With the clamping screw arranged as described, however, the operator simply loosens the screw enough to allow the latch *E* to be thrown back, after which the slide may be instantly run back far enough to allow the fork to clear the work.

The next operation consists of truing up the bottoms of the brackets on a planer equipped as shown in Fig. 3. A small planer is used for this work, on the table of which ten brackets are mounted at a time. The brackets are set on the fixture with the bored bearing holes located over the posts of the fixture. The drilled hole fits over a pin set in front of the post, and this serves to locate and hold the bracket in place. A washer and nut at the top of the post studs are employed to clamp the brackets securely in place. The faces to be planed are cast hollow, so that it is necessary to remove but little metal in order to obtain a true surface. This truing operation, however, is necessary, as otherwise

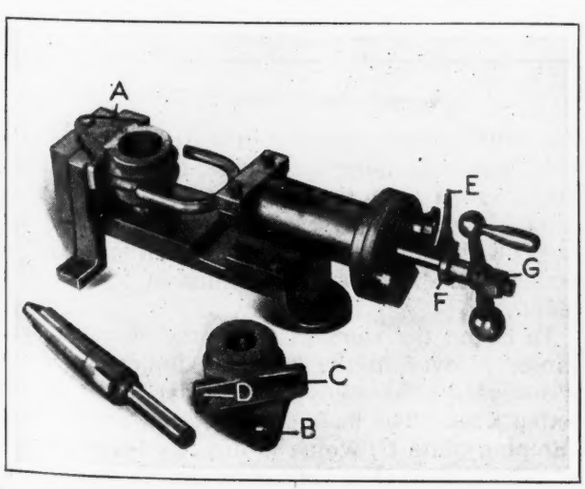


Fig. 1. Boring Fixture for Truck Axle Bracket

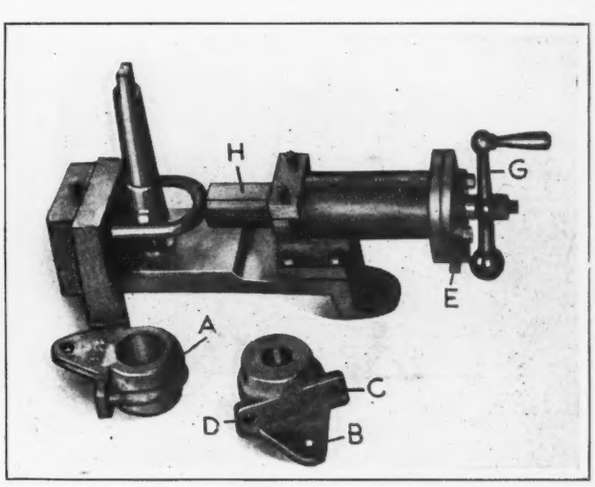


Fig. 2. Boring Fixture with Work Removed

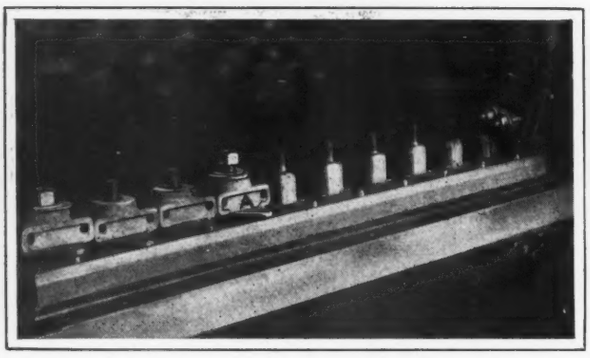


Fig. 3. Fixture for Holding Brackets while Planing

the axle bearings are likely to become cramped and cause trouble.

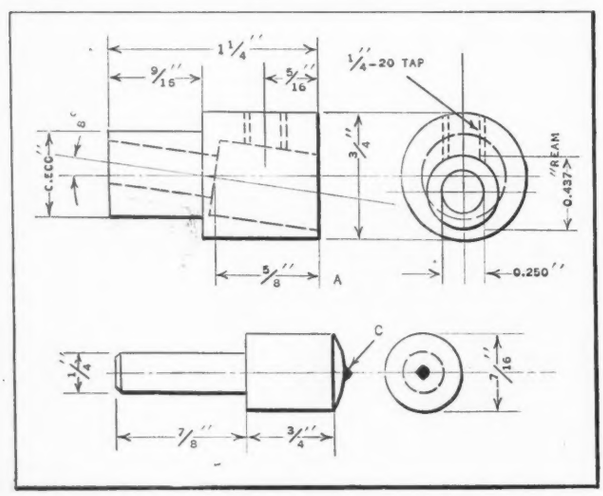
Cleveland, Ohio — AVERY E. GRANVILLE

IMPROVED HOLDER FOR TRUING DIAMOND

The points of grinding wheel truing diamonds that are in constant use on production grinding machines soon wear down to a flat spot or surface, with the result that overheating occurs and the life of the stone is shortened. A diamond, to be efficient, should retain a sharp point in order to keep the surface in contact with the grinding wheel as small as possible. A simple modification in the design of a diamond-holder furnished with a well-known make of grinding machine resulted in increasing the efficiency of the diamond for wheel truing and doubled the life of the stone.

The holder was turned to the dimensions shown at *A* in the accompanying illustration. The outside dimensions are the same as those of the holder furnished with the machine. The only change made in the new holder was in the position of the hole for the socket *B*, which is drilled at a slight angle with the axis. This angular position of the hole permits the diamond socket to be turned slightly whenever the diamond *C* begins to show too large a flat or worn point.

With a holder of this type, it is possible to present a sharp point to the wheel without necessitating the resetting of the stone until all the sides of the stone have been completely worn down. The improved holder does not, as might be supposed, change the relative position of the stone with respect to the radial line contact with the wheel, regardless of whether it is set above or below the center. Of course, for best results a diamond-holder should be set below center.



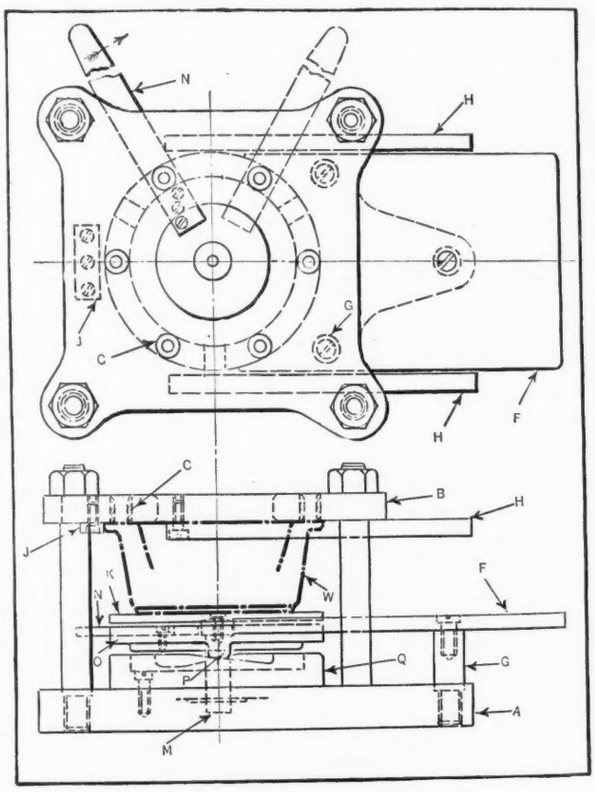
Improved Holder for Truing Diamond

Syracuse, N. Y. — H. L. WHEELER

JIG WITH LEVER-OPERATED CLAMPING CAM

The drill jig shown in the accompanying illustration is employed in drilling six clearance holes for bolts in the top flange of the brass casting shown by dot-and-dash lines at *W*. The top of the flange is finished previous to the drilling operation, which is performed in a multiple-spindle drilling machine. The feature of particular interest in the design of the jig is the method of clamping the work. The jig consists primarily of two plates *A* and *B*, the loading platform *F*, and the clamping members *K*, *N*, and *Q*. The top plate *B* is provided with the drill bushings *C* which are located in the proper positions for drilling the flange.

When the jig is in use, the work is placed on the platform *F*, which is set at the proper height on the three studs *G*, screwed into the baseplate. The work is pushed along the loading platform between the two rails *H* until it strikes the stop *J*. At this point, the casting leaves the loading platform and rests on the adjusting plate *K*, which rocks on the center stud *M*, the top of which is formed to a radius.



Jig with Rapid Clamping Device

To clamp the work in place, the operator pulls handle *N* over in the direction indicated by the arrow until it assumes the position shown by the dotted lines. The handle *N*, being attached to the clamping plate *O*, which is directly beneath plate *K*, causes plate *O* to rotate on stud *M* so that the three equally spaced risers *P*, on the bottom of

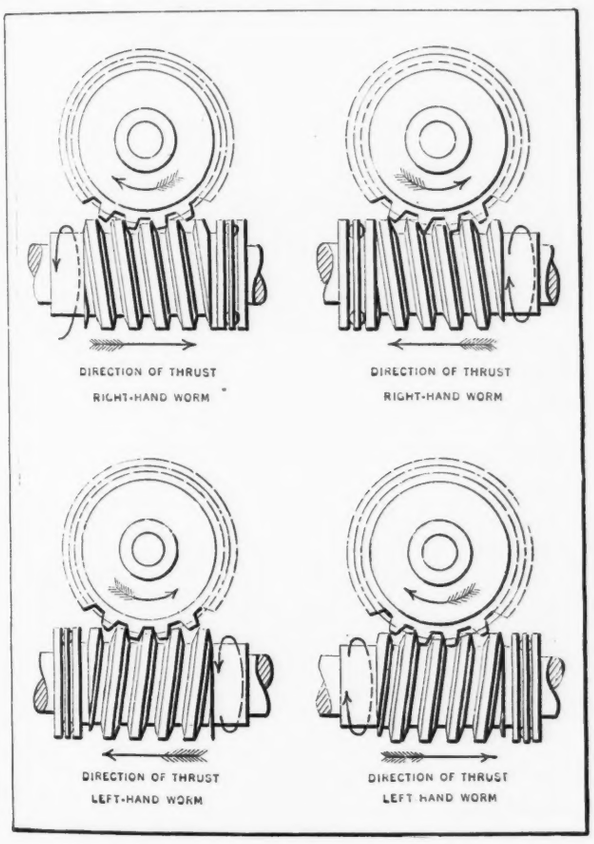
plate *O*, will follow the inclined cams formed on the top rim of the stationary plate *Q*. It is apparent that the risers *P*, which follow the cam surfaces on plate *Q*, cause stud *M*, which supports plate *K*, to be raised. This movement results in clamping the finished face of the work against the bottom of the top plate *B*.

The cam surfaces on plate *Q* have a very gradual rise of less than 5 degrees, which prevents the downward pressure of the drill from loosening the work. When the drilling operation is completed, handle *N* is pushed back, and the work is dropped down so that it can be withdrawn from the fixture along the platform *F*.

New York City — B. J. STERN

DIAGRAMS SHOWING DIRECTION OF WORM THRUST

The diagrams shown in the accompanying illustration were prepared to prevent confusion in determining the direction of the thrust of a worm.



Direction of Thrust for Right-hand and Left-hand Worms

These diagrams permit the designer and draftsman to see at a glance the direction of thrust for a given direction of rotation and for worms having either right-hand or left-hand threads.

Rochester, N. Y. — EDWARD T. HEARD

GRINDING STAND FOR FORMING TOOL

The grinding stand shown in the accompanying illustrations was originally designed for extra wide form tools for screw machines, but was soon found to have so many advantages that it was used for the general run of such tools. Chief among the advantages gained through the use of this device was the fact that a true edge was invariably obtained, with the ground surface always at the correct angle, which resulted in a longer life for the cutting edge. The time required to set up the work on the stand, as shown in Fig. 1, was in most cases negligible, and tools with a burned or badly damaged edge could be roughed off on another wheel before they were ground on the stand.

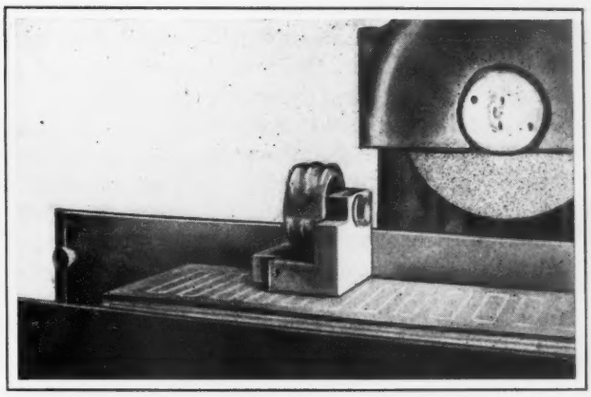


Fig. 1. Forming Tool Mounted on Stand Ready for Grinding

The stand shown takes the form tools of two different machines, namely the Nos. 2 and 4 B & S automatic machines. It consists of two cold-rolled steel blocks *A* and *B*, Fig. 2, screwed together at right angles to each other. Each block has, near its free end, a hole which closely fits the stem of the form tool clamp screw of one of the two machines, the center distance from this hole to the face of the other block being slightly in excess of the largest form tool radius. Ahead of this hole, there is a rectangular notch. This notch in the corner of the block permits the passage of the grinding wheel, the upright surface of the notch limiting the depth to which the tool can be properly ground, while the horizontal surface is just 1/32 inch below the plane in which the cutting surface of the tool should lie.

Changing from one size of form to another is, therefore, merely a matter of using one or the other side of the block as a base. The tool can be placed on either the inside or the outside surface of the upright, so that it is possible to get the registering or toolpost face registered against the upright sur-

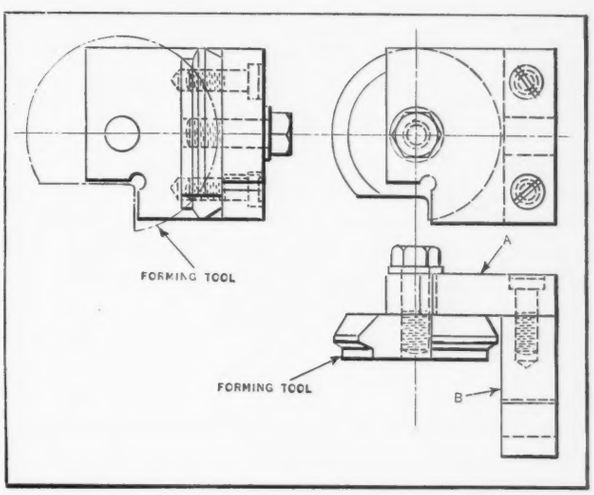


Fig. 2. Stand for Use in Grinding Forming Tool

face of the stand, no matter which way the edge happens to be ground. As the stand is very solid and has a broad foot, the overhang of the tool beyond the edge of the post causes no trouble.

The particular stand in question was designed for use on surface grinders equipped with magnetic chucks, but by merely providing a notch in each end surface and at each side of the corner between the screws, to give a hold for a clamp, the stand can be used on machines having a plain table.

When exact forming is required on relatively wide work, the use of this stand will avoid a vast amount of trouble resulting from errors in grinding the cutting edge. Ordinarily, such tools are sharpened on shop grinders provided with a stationary table, the cutting surface being held against the side of the wheel. As the wheel wears, however, the surface of the tool is likely to become concave or convex unless great care is used. If this happens, only part of the tool surface can be set central on the stock so that it will work as it should. It is not easy, under the conditions prevailing in actual work, to keep the side of a wheel trued up at all times, and while a few minutes more may be required to grind the tool on the stand, it was found that much more than the value of this time was invariably saved.

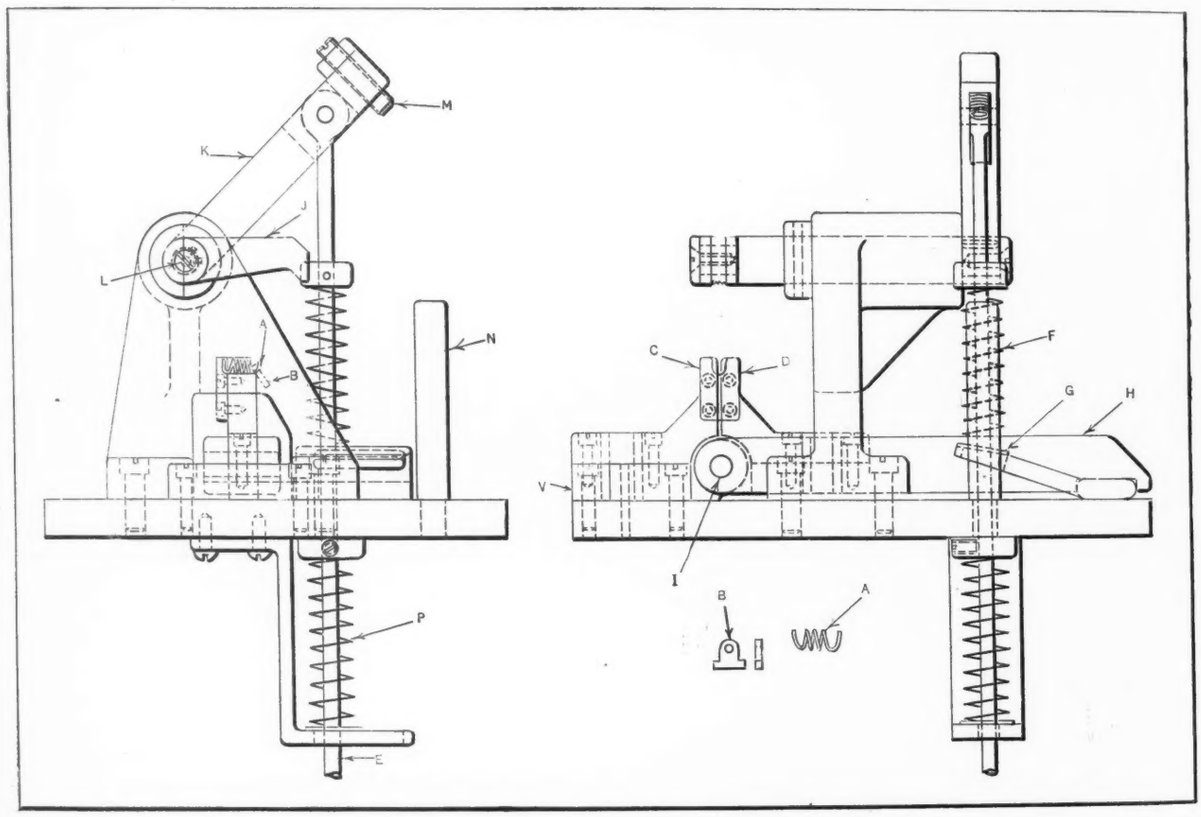
Jena, Germany — HENRY SIMON

TIME-SAVING ASSEMBLING FIXTURE

The fixture shown in the accompanying illustration is used in assembling the coil spring *A* and the trunnion *B*. It consists primarily of a vise for holding and locating the spring, and a bending member which clinches or bends over the end of the spring so that it is securely linked to the eye in the trunnion. When the fixture is in operation, the workman places a coil spring *A* in the locating nest, with the end to be bent in a vertical position between the plates *C* and *D*. The trunnion *B* is then placed over the end of the spring, as shown in the view at the left in the illustration.

Next the operator presses down the foot-pedal which is attached to the rod *E*. This compresses the spring *F*, which, in turn, forces the end of cam *G* downward. The other end of cam *G* is raised, causing lever *H* to pivot on pin *I*. The plate *D*, which is secured to lever *H*, is thus made to clamp the spring *A* in position.

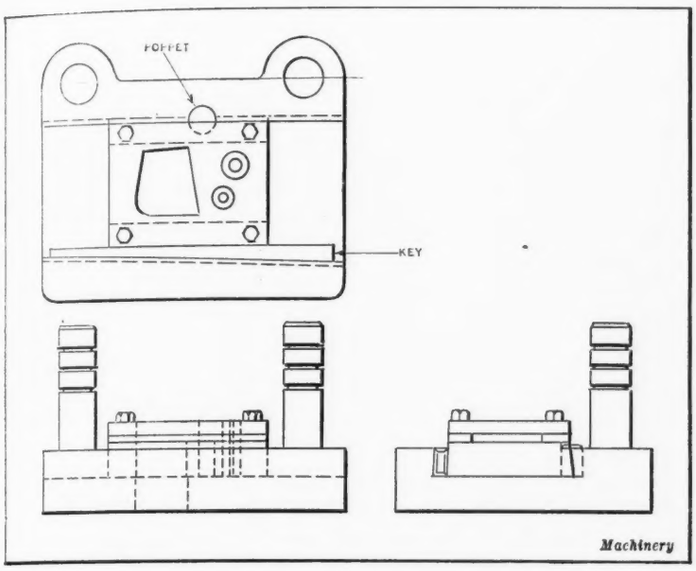
A further downward movement of the pedal brings the end of arm *J* into contact with the end of spring *A*, bending it over so that it retains the trunnion *B*. Arm *J* and lever *K* are both keyed to the shaft *L*. The set-screw *M*, coming in contact with the post *N*, serves to limit the downward movement of lever *K*. The amount of bend given the end of spring *A* is determined by the adjustment of screw *M*. With this stop arrangement, the ends of all the springs are bent a uniform amount.



Fixture for Assembling Spring and Trunnion

The point of arm *J* is knurled, in order to prevent the spring from slipping sidewise while being bent. The function of spring *P* is to raise the arm *J* and release the work-holding jaw *D* to permit the work to be removed. The use of the assembling fixture described has resulted in an increase of approximately 60 per cent in the production rate over the old method of bending or clinching the spring ends with pliers.

Bridgeport, Conn. — J. E. FENNO



Pillar Die Set with Removable Punch and Die Members

PILLAR DIE SET WITH ASSEMBLY PUNCH AND DIE MEMBERS

In spite of the many advantages of pillar die sets, they have several disadvantages which often limit their use. The first of these is the cost, especially in the case of small dies, where the expense is often twice as great as that of the ordinary type. Dies of the pillar type are also more difficult to grind, as they must either be taken apart for regrinding or be ground on a much larger machine than would otherwise be required.

The method here illustrated of mounting the die and punch in the die set was especially worked out to overcome these difficulties. The punch and die can easily be removed for grinding without taking the shoe from the press. As there is a minimum number of holes in the die sets, it is a simple matter to change from one set of tools to another. This construction also reduces the expense for die-shoes. The method is an adaptation of two well-known devices, the taper key method of holding dies, and the cylindrical "poppet" used to prevent drop-forged dies from shifting. The construction of the die is clearly shown by the illustration.

Riverside, Ill. F. MARTINDELL

A DRAWING-BOARD THAT REQUIRES NO T-SQUARE

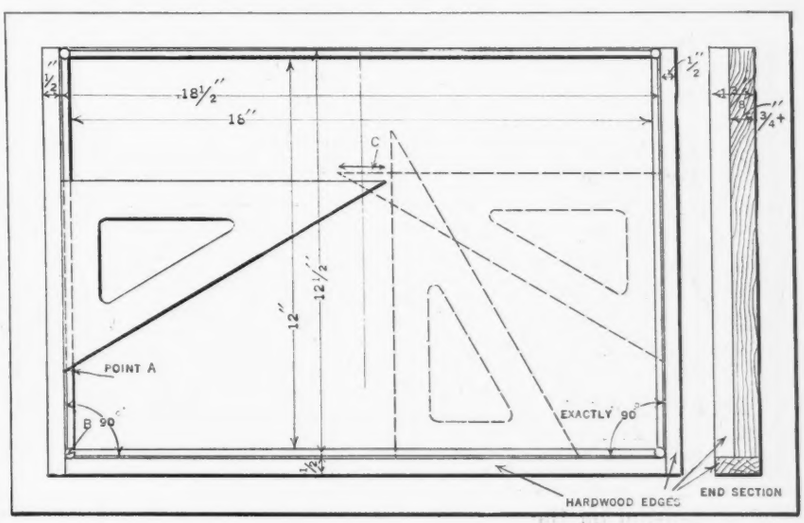
A small drawing- or sketch-board that the writer designed some years ago, while engaged in drafting work, is shown in the accompanying illustration. This board is ideal for small sketch work and a great convenience when making small working drawings. Its small size, and the fact that it requires no T-square, also makes it particularly well suited for shop, field, or home use.

The elimination of the T-square is accomplished by making the dimensions of the board such that a 10-inch, 30-60-degree triangle can be used to draw horizontal and perpendicular lines at any desired position on the board. To meet these requirements, the board is made 12 inches wide and 18 1/2 inches long by 1/2 inch thick. A frame of hard wood is placed around three sides of the board, as shown in the illustration. The edge of this frame projects upward about 1/2 inch. The pieces that form the frame take the place of the T-square and also serve as stiffeners to keep the board in shape.

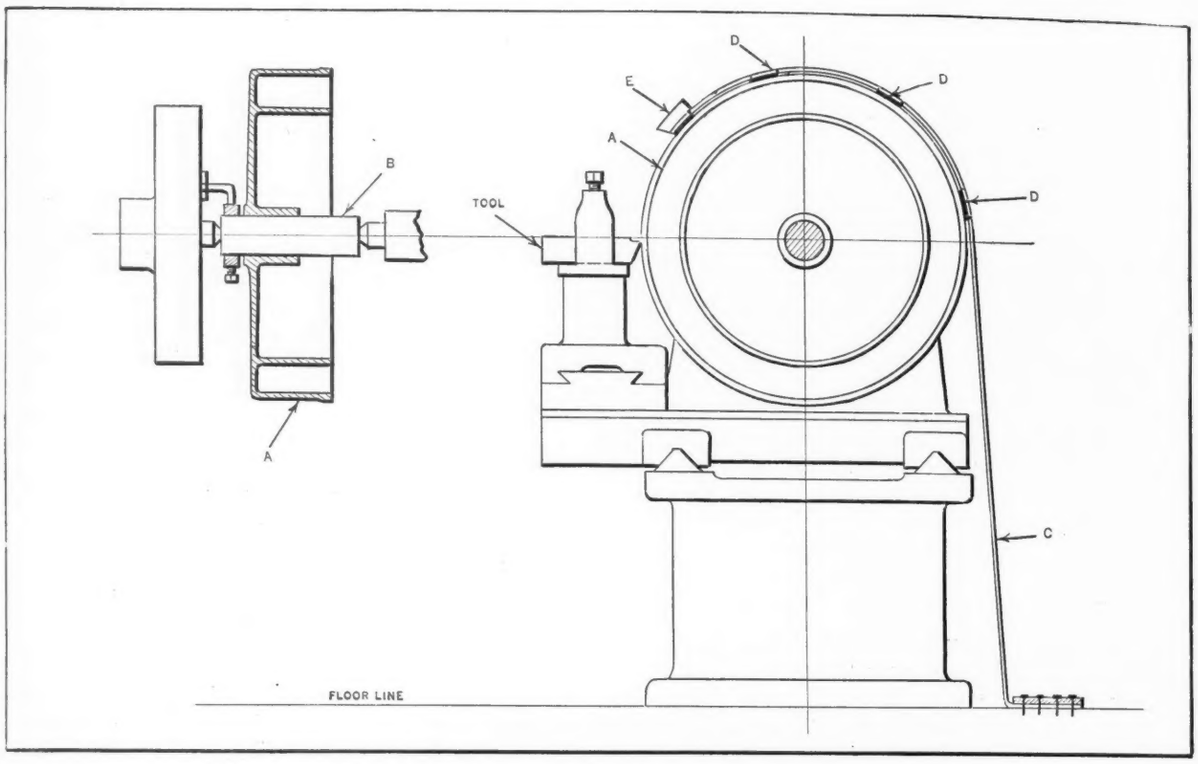
Oak is a good wood to use for the frame. It is very important that the two lower corners of the frame form exact right angles, so that the sides will be parallel. Careful checking and workmanship, and the use of screws in assembling the frame, will be required to insure the accuracy desired. After the parts have been accurately assembled, they may be taken apart and finally assembled, using glue as well as screws.

The drawing sheet is cut to any desired size that will fit in between the sides of the frame. When the drawing sheet has been tacked down, the single triangle is placed on the board and used for all horizontal as well as vertical lines. A horizontal line extending across the sheet, for instance, is drawn by changing the triangle from one edge to the other. The methods of using the triangles will be understood by referring to the illustration, where the different positions are indicated by the full and the dotted lines.

It will be noted that the triangle is long enough to permit an overlap at *C*. When the point *A* of the triangle meets point *B* of the board, the upper or ruling edge is still a considerable distance above the lower edge of the board, which necessitates turning the triangle over in order to draw horizontal lines near the bottom. The triangle can be more conveniently used in this position by turning the board around so that the bottom of the board is in the position previously occupied by the top. It may be well to suggest here that as the thumb-tacks must be used continuously within a very limited space, it is not desirable to use the softest pine for the drawing-board. A material somewhat



Drawing-board that Requires No T-square



Method of Dampening Vibrations to Prevent Chatter

harder than pine will not be cut away so quickly by tack holes.

White Plains, N. Y. MORRIS A. HALL

VIBRATION DAMPENER FOR LATHE

The writer was given the job of finishing some large steel castings like the one shown at *A* in the accompanying illustration. Not having a lathe with a chuck large enough to grip the rim of the casting, it was first necessary to bore the hole in the casting and then place it on an arbor *B* for finish-turning the periphery. When this was attempted, the tool chattered excessively and the cut was irregular and out of round. After trying a number of different types of cutting tools, the operator finally overcame the trouble by employing the simple device shown in the illustration, which served to dampen the vibration of the work and thus eliminate excessive chatter.

The device consists of a piece of leather belt *C*, one end of which is securely fastened to the floor at the back of the lathe as shown, wood cleats *D*, and a weight *E*. The weight *E* is just heavy enough to take care of the drag on the casting and keep a steady pull or tension on the periphery of the work. The proper amount of tension was determined by gradually increasing or decreasing the amount of weight used.

Bridgeport, Conn. A. PATANOVICH

MACHINING ECCENTRIC STRAPS ON A MANUFACTURING BASIS

The jigs shown in the accompanying illustrations are part of the equipment employed in machining eccentric straps like the one shown at *A*, Fig. 2, on a manufacturing basis. The straps are cast in two parts or halves. In the first operation, one side or face of the strap is ground on a Blanchard grinding machine. In the second operation, the faces of the straps at the joints *B* are faced on a milling machine. In the third operation, the straps are drilled and reamed while clamped in the jig shown at *C*, Fig. 2. Slip bushings like that shown at *D* are used to guide the drill and the reamer. The finished face of the strap is located on the pad *E* of the jig, and held in place by the C-clamp *F*. The set-screw *G* serves to hold the face of the bosses to be drilled against the pads *H* of the jig.

The tapping of the holes at *J* is done with the strap held in the jig shown in Fig. 1. This jig is provided

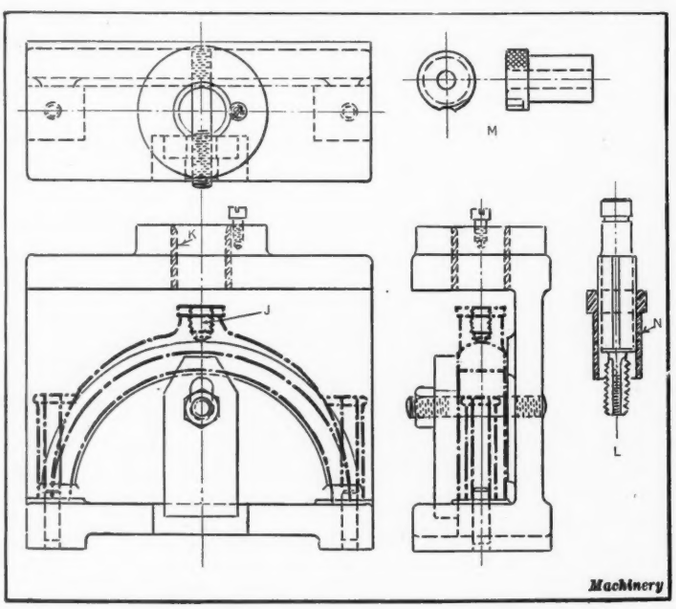


Fig. 1. Jig for Use in Drilling and Tapping Strap

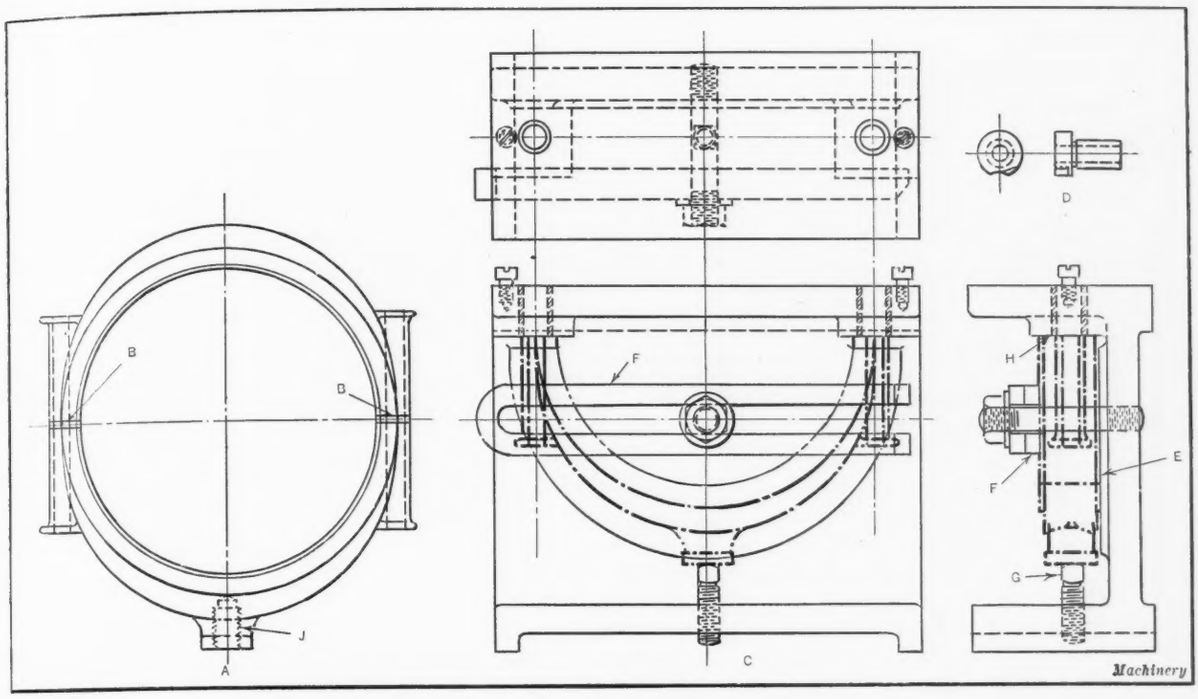


Fig. 2. Eccentric Strap and Drill Jig Used in Machining it

with a bushing *K* having a hole large enough to permit the use of a spot-facing tool for counterboring the column for the valve rod hole before the thread is tapped with the tap and holder shown at *L*. The slip bushing used for the tap drill is shown at *M*, and the bushing for the tap is shown at *N*.

The final operations of boring the strap to the dimension *X*, Fig. 3, and finishing one face of the strap are performed on a Bullard turret lathe. The base of the fixture shown in Fig. 3 is secured to the faceplate of the Bullard turret lathe, a plug *P* made to suit the hole in the faceplate being used to give the proper location. The clamping screws *R* are a sliding fit in the reamed holes in the work, and are provided with wing-nuts for clamping the two halves of the eccentric strap against the dividing strips *S*, which are the same thickness as the shims to be used in assembling the straps. It will be noted in the illustration that four sliding bushings *U* transmit the clamping pressure to the work. This means of locating insures interchangeability of the work. A size-block, which is indicated by the dot-and-dash lines at *T*, is used in setting the tool to the correct height for facing the side of the strap.

C. W. PUTNAM
Buffalo, N. Y.

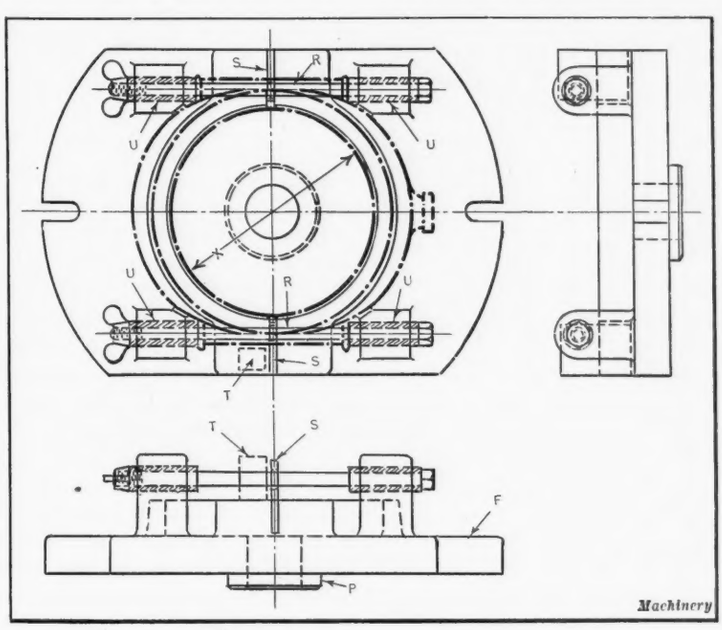
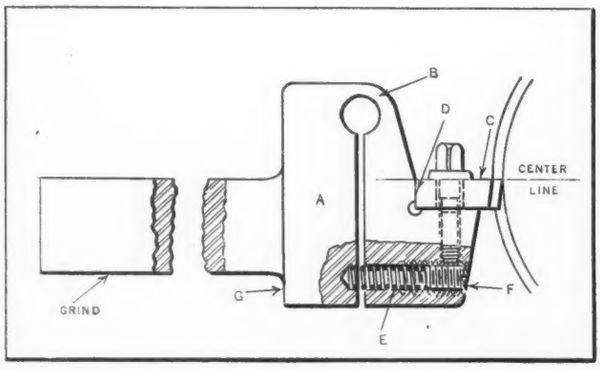


Fig. 3. Fixture for Holding Eccentric Strap while Boring

GOOSENECK TOOL WITH ADJUSTMENT FOR PRESSURE

Thin work will sometimes spring away from a forming or grooving tool and cause chatter, unless it is very well supported. At other times, the tool itself springs and digs into the work, causing the same kind of trouble. "Gooseneck" tools, which are so designed as to spring away from the work without digging into it again, are sometimes used on forming and threading work, with good results, and the one shown in the illustration possesses some advantages over the usual form, when used for comparatively light forming cuts. It is primarily designed for use in the cross-slide toolpost of a turret lathe, but with suitable modifications, it would be equally useful on other machines.

The body of the tool *A* is a low-grade tool-steel forging, preferably machined all over to the form shown, then hardened and the temper drawn to a good blue at *B*. The shank should be ground on the bottom and one side at least, so that it will have a good bearing in the toolpost. The tool *C* is of the flat variety, formed to shape and held down by screws. The hole should be slotted so that the tool will get a firm backing against the shoulder *D*.



Gooseneck Tool with Means for Adjusting Pressure

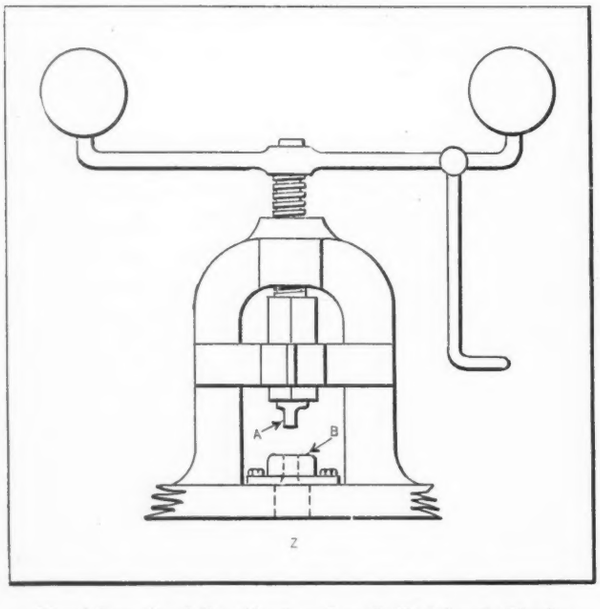
A feature of interest in this design is the introduction of a coil spring at *E* and a headless screw *F*, by means of which the pressure of the spring can be varied to suit the width of tool and resistance to cutting action. Another point worth noting is the shoulder at *G*, which in some forms of cross-slide toolposts gives exceptionally good support. For general all-around work and light forming cuts, this type of gooseneck tool-holder will be found very useful.

Detroit, Mich. ALBERT A. DOWD

SIZING BLACK ROLLED STOCK IN DIE

The usual practice in making button dies, of, say, 5/8 to 1 inch in diameter, is to use ground or bright drawn cast-steel bar stock of the correct size, and part or cut off the die blanks to the required thickness, leaving sufficient material to permit truing up the faces. The chief drawback to this procedure is the high cost of the ground or bright drawn material, as compared with the black rolled bar stock. The drawn material also has a tendency to twist or warp during the hardening process, owing to the cold working strains in the steel, which are not entirely relieved by annealing.

A rather novel method of overcoming these drawbacks was recently noted by the writer; by this method, ordinary black rolled bar steel was parted or cut off to the usual thickness in a screw machine, and sized in a large hand press similar to the one shown in the illustration. A power press of sufficient capacity could probably be used as satisfactorily as the hand press. The bars of black rolled steel are usually from 0.005 to 0.020 inch over size, and are often oval or egg shaped.



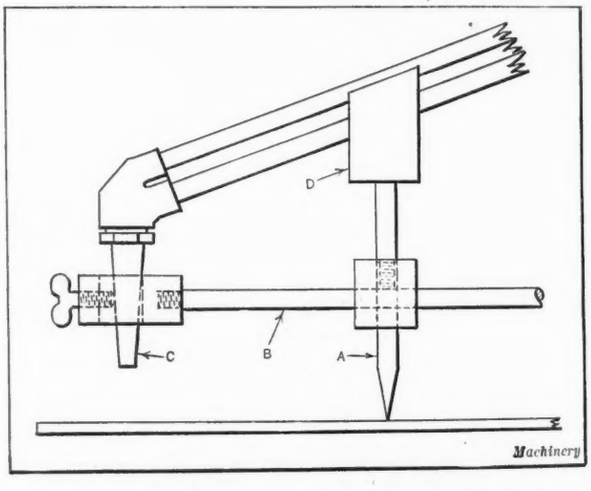
Hand Press and Die Used to Size Rolled Stock Blanks

Referring to the illustration, the punch *A*, which forces the black rolled steel blanks through the die *B*, is made of hardened cast steel, and is approximately 1/16 inch smaller than the blank to be sized. The die-block *B* is also of hardened steel, and has a bell-mouthed hole ground at the central portion to the exact diameter required on the blanks. By placing the blank in the outer mouth of the die-block and giving the handle of the press a quick swing to the left, the blank is forced through the die. The die sizes the blank very accurately, and also gives the work a smooth burnished finish. The blanks are faced up in the ordinary manner after the sizing operation. The facing operations also serve to remove the burrs produced in the sizing operation.

London, England ROBERT JULIAN

CIRCULAR ATTACHMENT FOR CUTTING TORCH

An attachment to be used with a cutting torch for cutting circular openings, circular plates, etc., is shown in the accompanying illustration. The attachment consists of a pointer *A* which is adjustable along rod *B* to vary the distance between the pointer and the torch tip *C* according to the radius required. The torch tip is held in position by the thumb-screw shown, and the torch is further supported by block *D*, which is cut out to receive it. This attachment was made by David Pearson, welder foreman, San Bernardino Shops, Atchison, Topeka & Santa Fé Railway Co.



Adjustable Attachment for holding Torch while Cutting Circular Openings or Plates

San Bernardino, Cal. J. R. PHELPS

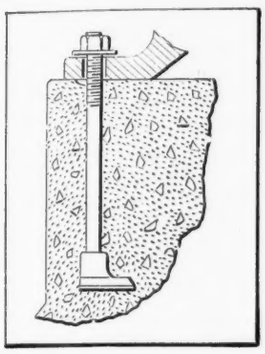
* * *

The trouble with most taxes on capital and other legislative demands at clipping its wings is that they levy tribute on the operations of successful enterprise and management, and it is enterprise and management that turn the wheels of industry. —*Commerce and Finance*

Shop and Drafting-room Kinks

ANCHOR BOLT MADE FROM DISCARDED ENGINE VALVE

In searching for a suitable means for fastening down the frame of a fountain, the writer discovered that old poppet valves from a Ford engine, such as are thrown away by garages, could be quickly and easily made into anchor bolts. A 5/16 standard thread can be easily cut on the stems of these valves, as shown in the accompanying illustration. The valves are made from a good tough grade of metal and have considerable holding power.

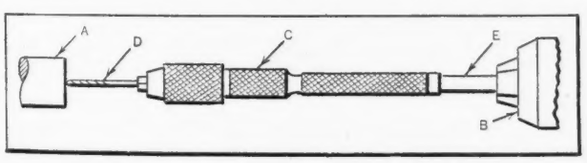


Old Engine Valve Used as Anchor Bolt

The heads of the valves are ground off on one side to provide a surface that will have sufficient resistance to prevent the valve from turning when tightening down the nut. Anchor bolts made in this way have also proved very satisfactory for holding down small machines. F. W. B.

SENSITIVE DRILLING IN THE LATHE

The problem of drilling a No. 60 hole through a piece of 5/8-inch drill rod, 3/4 inch long, with the hole accurately located on the axis of the piece, was not an easy task in a shop not equipped with a small sensitive lathe. As the method of holding the drill in the chuck in the tailstock was not suited



Pin Vise Used for Sensitive Drilling

for this kind of work, the arrangement shown in the accompanying illustration was employed. The piece *A* to be drilled was gripped in the chuck of the lathe spindle and spot-centered with the combination center drill held in the chuck *B*, which was mounted in the tailstock spindle.

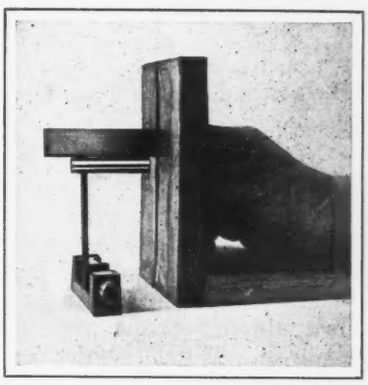
A small pin vise *C* of the sleeve chuck variety was used to hold the No. 60 drill *D*. A drill *E*, which was a sliding fit in the hollow handle of the pin vise, was gripped in the tailstock chuck with the shank end out, and the pin vise slipped over the projecting end. The tailstock was allowed to remain stationary, the work-spindle run at high speed, and the pin vise holding the small drill was gripped between the thumb and finger and gently pushed toward the work. The pin vise was thus caused to slide on the shank of drill *E*.

Everett, Mass. JAMES A. KIRK

ANGLE-PLATE FOR SQUARING AND TESTING WORK

The writer has always found it somewhat awkward to use a square in the ordinary manner for setting up work parallel to the surface plate. If the square is held against a parallel bar or angle-plate, the fingers are in the way and it is difficult to hold the square tight against the vertical surface. To facilitate the use of the square for this purpose, the small angle-plate casting shown in the accompanying illustration was provided.

The bottom face of this angle-plate is planed and one inside face is planed at right angles to the bottom surface. A slot is cut down the center of the upright member, so that the blade of the square can be slipped through. The slot permits the square to be slid up or down as required in testing or setting up work. The method of using the square and angle-plate is shown quite clearly in the illustration. It will be noted that the angle-plate can be held down and the square adjusted at the same time with one hand.

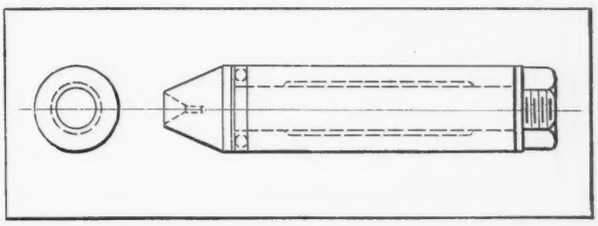


Angle-plate for Squaring and Testing Work

Hamilton, Ont., Canada ARTHUR KENDALL

ROTARY STOP FOR AUTOMATIC SCREW MACHINE

The rotary stop shown in the accompanying illustration has been successfully applied to automatic screw machines employed in making large quantities of pivot screws. The points of these screws are required to be kept smooth. Therefore, an ordinary solid stop is not suitable for this work, owing to its tendency to mar the point of the screw, in which case an additional grinding operation



Rotary Stop for Automatic Screw Machine

would be necessary. In order to eliminate this extra operation, the writer designed the ball thrust rotary stop shown in the illustration.

Portland, Conn. WILLIAM T. BROWN

Questions and Answers

WELDING CRACKED CYLINDERS

A. S. C.—Is there any method by which automobile cylinders that are cracked as the result of freezing can be welded without preheating? We have tried several methods, including brazing with bronze and welding with nickel rod. An alternating-current electric arc welder has also been used, but with little success.

Answered by R. E. Kinkead, Chief Engineer, Welder Division, The Lincoln Electric Co., Cleveland, Ohio

The writer's experience in connection with 100 or more " stable-arc" welders sold by the Lincoln Electric Co. has been that this kind of work can be done much quicker and at lower cost by the electric arc process, using an ordinary steel welding rod, than by any other method tried.

The cracked water jacket is merely welded shut with the ordinary steel rod, welding intermittently, that is, welding for ten seconds and then stopping for three minutes, taking care to spread the heat uniformly over the area welded. After the weld has been made, the crack is rusted shut with a sal-ammoniac and water solution.

Most of this work can be done without taking the engine down and with no disassembling work whatever. The only objection that could be raised to the practice is that it is not a water-tight weld until it is thoroughly rusted shut. However, as a rule, the owner of the car is not interested in whether it is an absolutely water-tight weld but in whether or not he can use his car. The method described is the quickest and cheapest way known to the writer. Welds examined after a period of four years have been found to be entirely satisfactory, and the method may be considered as producing a permanent job.

Answered by T. C. Fetherston, The Linde Air Products Co., New York City

Cast-iron automobile cylinders can be successfully welded without preheating by using bronze welding rod, and employing a few ordinary precautions. When the crack is in the water jacket and is at a reasonable distance from bolts and attachments, it is often unnecessary to remove the block from the car. Wiring and other attachments can be removed from the vicinity of the weld, and conduction of heat back into the casting can be retarded by packing the block with wet asbestos fiber cement along the crack at a distance of two or three inches from the crack on each side. It is not necessary to bevel the edges of the break, but the metal should be carefully cleaned of all oil, grease, rust, dirt, or other foreign matter, and preferably ground bright for about one half inch on each side of the break. Most of the failures in bronze welding result from improper cleaning of the casting before welding.

The oxy-acetylene blowpipe is used, and the best results are obtained with a welding rod prepared especially for bronze welding on cast iron, such as No. 10 bronze manufactured by the Oxweld Acetylene Co. and Tobin bronze manufactured by the Anaconda Copper Co. It is necessary also to use a good flux. Much work of excellent quality has been accomplished with a commercial flux known as "Brazo."

The temperature at which bronze welding is conducted is quite critical, and there is a relatively narrow range at which the best work is done. If the casting is not sufficiently heated, the bronze will not adhere firmly, and if it is raised to too high a temperature, the bronze will run off like water on a hot stove. The best rule is to practice on a piece of cast iron until the operator can tell from his own experience the correct temperature, which should be the heat just below a dull cherry red.

A section of the break should be brought up to this temperature, the metal being heated along both sides of the crack for about 1/4 inch. The bronze welding rod should be heated, and then dipped in the flux. A sufficient quantity of flux for initial application will adhere to the heated rod. Next, the bronze rod should be melted and allowed to run on the heated section of the casting, a very thin layer of bronze metal being flowed on the break. This first layer should be applied as a sort of tinning layer similar to the tinning which is done as a preliminary step to soft soldering, and care should be taken to see that the section to be welded is entirely covered by this tinning coat. After the tinning coat has been applied, bronze weld metal can be added fairly rapidly, using flux as necessary, until a weld of the proper height has been built up along the break.

Welding should start at least 1/2 inch beyond the visible ends of the crack. If the crack is long, it may be desirable to tack-weld it in one or two places or to begin welding in the center and weld toward both ends. Avoid overheating the base metal or the bronze weld metal. Overheated or so-called "burned" bronze will be purplish in color and have very little strength.

Bronze-welding should be done in a well ventilated shop or in the open air. The operator should avoid breathing the white fumes of volatilized zinc oxide produced, since this may cause him a little discomfort if breathed in large quantities. When the weld is completed, it should be allowed to cool, and then can be filed or ground down smooth and even, although grinding flush with the cylinder wall should be avoided unless the crack has been beveled.

* * *

According to a report by the Department of Manufacture of the Chamber of Commerce of the United States, there are now over 1,350,000 workers in this country employed under the representation plan. There are 432 separate companies operating this plan, and more than 900 works councils are active.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

KEARNEY & TRECKER PRODUCTION-TYPE MILLING MACHINES

Simplex and duplex models of a new production-type milling machine known as the "Mil-Waukee-Mil" were introduced on the market at the Cleveland Exposition by the Kearney & Trecker Corporation, Milwaukee, Wis. Full views of the simplex and duplex machines are illustrated in Figs. 1 and 2, respectively. Both models are built on a unit plan, so that a customer may purchase only such units as are necessary for any particular operation.

Starting with the simplest forms, which are equipped with but one set of pick-off gears each for making speed and feed changes, the models can be built up until they become fully automatic with a wide range of intermittent table feeds, power rapid traverse, spindle start and stop controls, etc. The list of standard units that may be applied before or after the machine is in service includes complete sets of pick-off speed gears, complete sets of pick-off feed gears, a quick-change speed gear-box, a quick-change feed gear-box, an automatic feed control, an automatic spindle start and stop control, a spindle reversing unit, a centrifugal pump and coolant system, and a motor-in-bed drive.

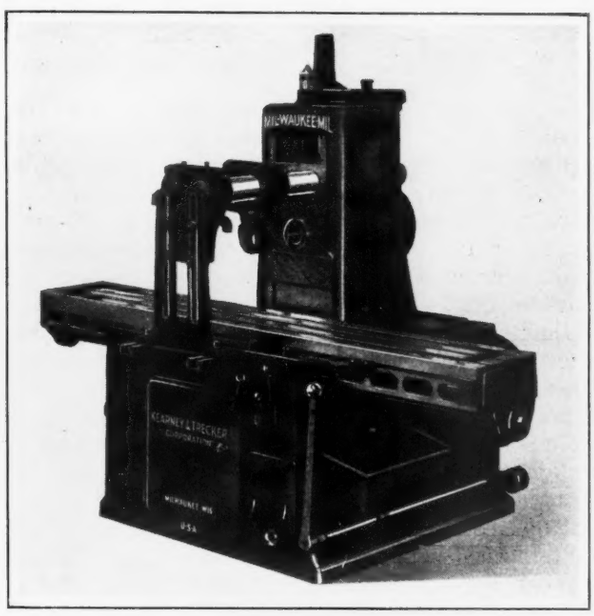


Fig. 1. Simplex Model of "Mil-Waukee-Mil" Built by the Kearney & Trecker Corporation

Other features of construction include a double housing for the spindle block; double over-arm support for the arbor; Timken tapered roller bearings throughout the drive, including the main spindle; planer type table; and automatic flooded lubrication for the spindle bearings and for all mechanism in the bed, including the table ways.

Referring first to the simplex model, the bed is approximately 4 feet square and contains two large reservoirs, one for the automatic pump and lubrication system, and the other for the cutter coolant and centrifugal pump. Coolant channels on top of the bed completely surround the table and drain into the reservoir. The table is 92 inches long by 14 inches wide and is located 32 inches above the floor. It can never be moved far enough to uncover the ways at either end of the bed, there being always 42 inches of bearing surface length beneath the table. There is a power feed 48 inches in length.

The spindle and double over-arms are contained in a solid block which has a vertical adjustment of 12 1/2 inches between the walls of the double housing. This block can be firmly locked to the housing, the minimum and maximum heights of the spindle center above the table being 3 and 15 1/2 inches, respectively. This vertical spindle adjustment is accomplished by means of a screw located at the upper left-hand side of the double housing and provided with a micrometer dial graduated to 0.001 inch. The drive to the spindle is through a spiral bevel gear and pinion, the gear being mounted solidly on the spindle close to the front end. The back end of the spindle is fitted with a heavy flywheel that is completely guarded. There is also a cross adjustment of the spindle block and housing of 8 inches, which is accomplished by means of a screw at the rear of the bed. This screw is also equipped with a micrometer dial graduated to 0.001 inch.

When either the simplex or duplex machines are furnished in their simplest form, there is a box at the top of the double housing arranged to receive pick-off speed gears. These gears are between two centers only. There is a selection of four different ranges of speeds, 15 to 150, 20 to 200, 30 to 300, and 50 to 500 revolutions per minute, respectively. In each range, twelve speeds are obtainable with six pairs of gears.

Also, when the two models are in their simplest form, a bracket bolted to the front of the bed at the right-hand end and furnished with a hinged cover, provides a housing for pick-off gears for the table feed. There is a selection of two feed ranges, from 1/2 to 20 or from 1 to 40 inches per minute. In each range, eighteen feeds are obtainable with various combinations of nine gears. The pick-off feed-gear compartment may be seen at the right in Fig. 3.

There are but three control levers on the plain simplex machine, located at the right-hand end of the bed as seen in Fig. 1. The upper of the two short vertical levers is used for controlling the power table feed, and the lower lever for controlling the power rapid traverse which functions at the rate of 240 inches per minute in either direction. Dogs on the front edge of the table trip out the power feed at either end of the stroke, and a third

dog can be located to trip the rapid traverse as the work approaches the cutters and just before the cutting feed is engaged. The long lever at the right is for starting and stopping the main spindle. The rapid traverse may be used for returning the table or running the work up to the cutter while the spindle is standing idle. On the plain machines, all controls, except the trip-dogs, are manually operated.

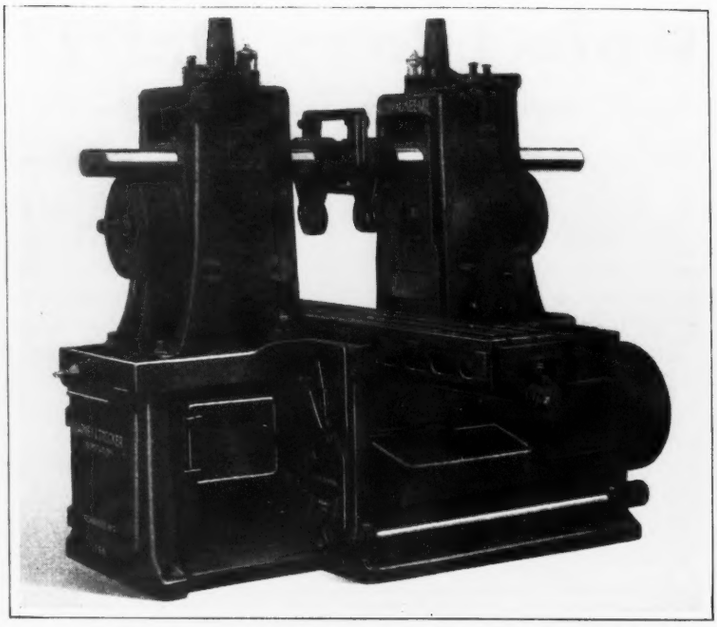


Fig. 2. Duplex "Mil-Waukee-Mil" Production-type Milling Machine

Practically the entire machine is automatically lubricated from one central filling station at the front of the bed. A geared pump connected to the main-pulley drive bracket distributes oil from the reservoir in the bed to all parts of the mechanism, including the spindle gear train, spindle bearings, feed mechanism, gear-boxes, and the table ways. There is a glass-covered oil-flow indicator on top of the double housing, which enables the operator to see whether or not the lubrication system is working properly.

As may be seen in Fig. 4, there is a compartment within the bed for a 15-horsepower motor. In this position, the motor is accessible both from the side and back of the machine through ventilated doors. Power is carried from the motor by means of a 5-inch belt to a pulley driven at 600 revolutions per minute. A weighted idler automatically provides the necessary belt tension. When arranged for a belt drive from an overhead lineshaft, the machine pulley is mounted on the same initial drive shaft, but a 4-inch belt is used.

The duplex machine is identical in construction to the simplex model, with the exception that the bed is extended beyond the table ways for attaching the second or left-hand head. All the mechanism within the bed is the same as in the simplex model, excepting that the horizontal drive shaft extends all the way through to connect with the bevel gear on the vertical drive shaft for the left-hand spindle. The drum control for the automatic table feed is moved forward, so that instead of being directly at the front of the bed, as on the simplex machine, it is located at the left-hand end of the duplex machine bed casting.

In many shops, there are milling jobs coming through in reasonably small quantities that could be handled to advantage on a production-type miller, provided the machine was a little more versatile than the completely automatic or special-purpose machines usually built for mass production. It is for this class of work, that the Kearney & Trecker Corporation has provided both quick-change speed and feed gear-boxes as extra units. The quick-change speed gear-box is interchangeable with the pick-off gear-box on top of the spindle block housing. It consists of a three-lever sliding-gear transmission having a direct-reading plate and providing eighteen speeds from 15 to 300 revolutions per minute. By merely removing the top cover plate and transposing the two range gears, it is possible to secure an additional range of eighteen speeds from 30 to 600 revolutions per minute.

The quick-change feed gear-box is bolted into the right-hand side of the bed in back of the table.

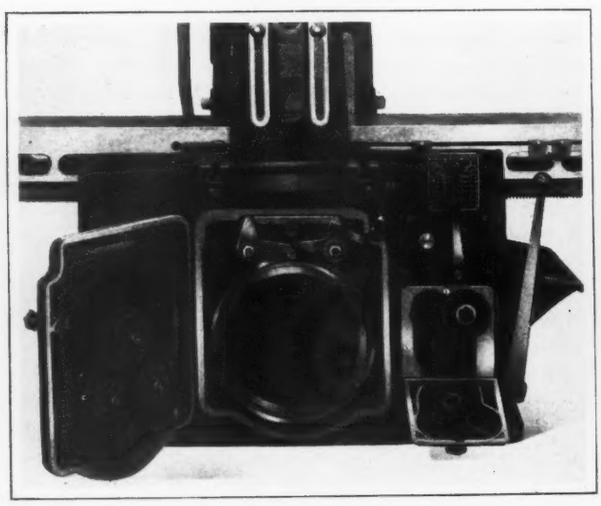


Fig. 3. Automatic Feed Control and Pick-off Feed Gears

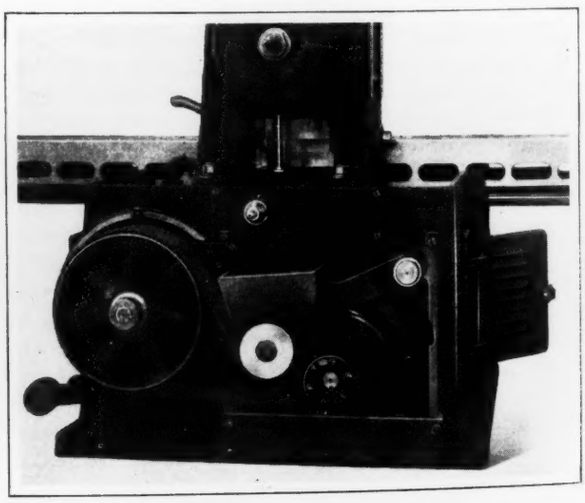


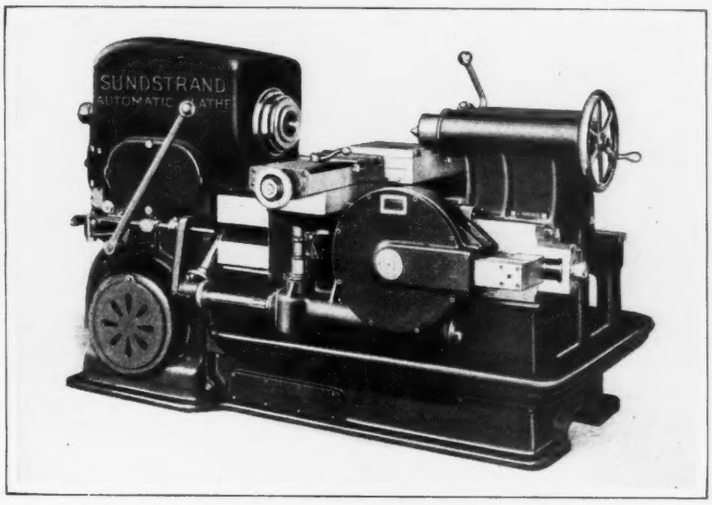
Fig. 4. Arrangement of Motor-in-bed Drive

Like the speed box, it is of the sliding-gear transmission type and has three control levers and a direct-reading plate. Eighteen feeds, giving a range of from 1/2 to 20 or from 1 to 40 inches per minute, are available.

The automatic feed control unit is in the form of a drum that is accessible through the large door at the front of the simplex machine or at the left-hand end of the duplex machine. As seen in Fig. 3, this drum carries dogs which operate the feed control and power rapid traverse clutches, where such operation is necessary and is not taken care of by the table dogs. When the automatic feed control is provided, there is an additional control lever located near the upper right-hand corner of the door which encloses the drum mechanism. This lever may be set to reengage automatically at the completion of each cycle, but it is usually manually operated so that when the table returns into the loading position, it will stop until the operator has had time to reload the fixture and again throw in this lever to start the automatic cycle. A large variety of cycles may be obtained, including intermittent feed with power rapid traverse in either direction.

The automatic spindle start and stop control is furnished only in connection with the automatic feed control. It is so constructed that the spindle stops whenever the power rapid traverse is engaged, and remains stationary until the feed is again engaged. When the spindle reversing unit is applied, the horizontal drive shaft in the base of the machine is equipped with bevel gears and a reverse clutch, so that the spindle can be run in either direction. A lever for reversing this clutch is accessible through a door in the bed. This reversing unit may be applied to either or both heads of duplex machines.

A centrifugal pump having a capacity of 16 gallons per minute is provided with the coolant system. This pump is attached to the pulley bracket on the inside of the bed and delivers coolant through a 1 1/4-inch pipe to the top of the bed. From this point the coolant is delivered through a flexible metallic hose to a pair of 1-inch distributing pipes which are supported from the double over-arms and provided with separate regulating valves. Three distributing pipes are supplied on the duplex machine, two for the right-hand spindle and one for the left-hand spindle. Two sheet-steel pans fit under the table to catch any coolant not discharged within the bed itself. The net weight of the simplex machine is approximately 8000 pounds, and of the duplex machine, 10,700 pounds.



Sundstrand High-production Automatic Lathe

SUNDSTRAND AUTOMATIC LATHE

An automatic lathe just placed on the market by the Sundstrand Machine Tool Co., Rockford, Ill., was developed after an intensive investigation concerning the production requirements of nearly 400 different kinds of parts in common use in the automotive, electrical, household appliance, railway, and farm implement fields. Charts were made up during the analyses to show the requirements of each individual part as to the desired maximum and minimum spindle speeds of the machine, maximum and minimum feeds of the front and rear tools, maximum and minimum approaches of the front and rear tools, the desirability of a third tool, and the preferable amount of clearance to give ample reloading facilities. The parts analyzed ranged from 4 to 10 inches in diameter.

At the end of the investigation a careful summary was made, and the machine was designed to more than meet the conditions determined. For instance, it was found that the front carriage should have a longitudinal feed of from 0.375 to 4.25 inches. It was actually designed to have a minimum feed of 0 and a maximum feed of 7 inches. The machine was exhibited at the Cleveland Show.

The headstock and bed are designed as an integral unit, and the rear carriage is mounted in such a way that it is practically integral with the headstock and tailstock and yet is adjustable to facilitate setting up work. The distance from the floor to the spindle is 39 inches. One of the main aims in the design was to reduce the required floor space to a minimum. This was accomplished by permitting the carriage to pass both the headstock and tailstock and making the headstock and bed integral.

The automatic lathe may be driven direct from a lineshaft or from a motor completely enclosed in the base. On the main drive pulley there is a "Twin Disc" clutch capable of transmitting 30 horsepower, which is approximately twice the power required for the heaviest cuts within the capacity of the machine. Pick-off gears transmit power from the clutch to the main drive shaft, the final drive to the spindle being through worm-gearing of the type used in truck rear-axle drives. The spindle runs in adjustable taper bronze bearings, and is equipped with a ball thrust bearing. Its construction permits the use of air-operated chucking devices, and air-operated devices may also be used on the tailstock.

The feed-box is of simple construction, having one clutch for the feed and two clutches for the rapid approach and reverse of the front and rear

carriages at the rate of about 70 inches per minute. The front carriage is 28 inches long and is fed longitudinally by a 14-inch diameter worm-wheel having a cam on each side. When the carriage is fed, one cam engages its corresponding roller to produce a feed of 3 1/2 inches. Then, when the worm-wheel has made one-half a revolution, the cam on the opposite side engages its roller as the first cam disengages, and feeds the carriage another 3 1/2 inches. This gives a total feed of 7 inches. If less than 3 1/2 inches of feed is required, one of the rollers is disengaged and only one cam used. The cross-slide may be fed to the required depth or to take a facing cut, before the longitudinal feed starts. Reversal of the cross-slide and the carriage can be accomplished simultaneously to give a triangular movement to the cutting tool. The front cross-slide has a power cross-feed of 2 inches.

The rear carriage may be placed in any position to suit the work. It can be arranged with a longitudinal power feed when desired. Power feed of the cross-slide is obtained by means of worm-gearing and a cam, the incorporation of a variable-stroke bracket allowing feeds up to 5 inches long to be employed.

A third vertical tool may be provided at any time, the driving arrangement for this tool being incorporated in the standard machine.

Some of the important specifications of the machine are as follows: Maximum swing over front and rear cross-slides, 13 and 15 inches, respectively; maximum swing over front and rear carriages, 18 1/2 and 15 inches, respectively; maximum swing over ways, 22 inches; diameter of hole through spindle, 2 1/4 inches; number of spindle speeds, 12; number of feeds, 10; minimum and maximum distances from point of center to face of spindle nose, 4 1/2 and 20 3/4 inches, respectively; and floor space required, 75 by 55 inches.

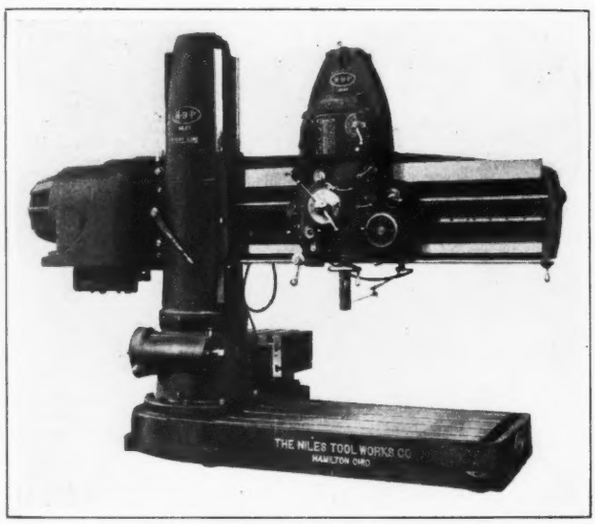


Fig. 1. Niles Radial Drilling Machine of New Design

NILES RADIAL DRILLING MACHINE AND POND LATHE

A Niles No. 25 heavy-duty "Right Line" radial drilling machine and a Pond 27-inch "Time Saver" lathe were exhibited at the Cleveland Show by the Niles-Bement-Pond Co., 111 Broadway, New York City. The drilling machine was developed to supplement the No. 10 medium-pattern "Right Line" machine, and while it retains some of the characteristics of the previous machine, it also embodies many changes. The new machine is illustrated in Fig. 1. It may be driven by either a constant- or a variable-speed motor, and is built with arm lengths which permit drilling radii of 6, 7, and 8 feet. The motor is of 20-horsepower capacity; it is mounted on the end of the arm behind the column, and is connected to the arm shaft through a flexible coupling.

The construction of the head is considered the most interesting feature. All speed changes are made in the head itself through selective sliding gears shifted by ball-socket levers. There is a 100 to 1 speed range, the minimum speed being 12 revolutions per minute and the maximum, 1200 revolutions per minute. With a direct-current variable-speed drive, this range is effected with three mechanical changes of speed made by shifting one lever, in combination with the variation of motor speed. With an alternating-current constant-speed drive, twenty-four spindle speeds are obtainable mechanically through the movement of three levers. A plate attached to the head shows the correct position of the levers for the desired speeds. Reversal of the spindle for tapping and other operations is accomplished by reversing the motor.

Sixteen feeds ranging in geometric progression from 0.005 to 0.125 inch per revolution are available, including feeds corresponding to pipe tap leads for threads of 8, 11 1/2, and 14 per inch. The feeds are varied by means of two levers, and an index-plate indicates the feed selected. A large graduated dial provides for tripping the feed at the desired depth, and trips are also furnished for disconnecting the feed mechanism at either end of the spindle travel.

The head is moved along the arm either by hand or by power, the rate of power traverse being 25 feet per minute. The arm slides on four V-ways on the column. A single lever serves the dual purpose of elevating or lowering the arm and clamping it to the column. The rate of the arm elevating traverse is 35 inches per minute. The column rotates with the arm, the lower end of the column being of circular section and extending into the pedestal. The clamp used to force the column against the top surface of the pedestal is operated by a 1/4-horsepower motor that is controlled by a switch on the head. Provision is also made to clamp the column with a hand-lever. Every control of the machine is centralized on the head, with the exception of the arm-elevating lever which ordinarily is used only a few times a day. The net weight of this machine equipped with motors and having a 6-foot drilling radius is approximately 28,000 pounds.

The new lathe closely follows previous machines of the "Time Saver" line, but has a headstock equipped with Timken tapered roller bearings and solid six-spline shafts for the sliding gears. The driving gears have been increased in size, and there is a greater range of spindle speeds. Other fea-

tures include a taper attachment of new design, and an improved carriage having wider slides. The improved machine is shown in Fig. 2 equipped with a 20-horsepower variable-speed direct-current driving motor and a 1-horsepower motor for operating the carriage, rapid power traverse, and coolant pump. Four mechanical spindle speed changes are available which, with the speed variation in the electrical control, provide faceplate speeds ranging from 4 to 220 revolutions per minute.

In the improved machine, the position of the driving motor has been reversed; that is, instead of the motor pinion and mating gears being located at the left-hand end of the headstock, they are placed at the right-hand end. This construction allows the use of motors of various types with frame sizes larger than usual, without the disadvantage of the motor extending toward the faceplate or chuck and thus obstructing the operator when setting up work. At the same time, motors of higher or lower speeds than normal and gear ratios to suit requirements may be used without any radical changes in headstock design.

A patented feature of the lathe consists of a jog push-button switch, which serves the dual purpose of enabling the operator to shift gears and to "inch" the faceplate or chuck in small increments when setting up or testing work. This switch is located between the gear-shift levers and the faceplate.

The one-horsepower motor delivering power for rapidly traversing the carriage is mounted at the rear of the machine. This motor is connected through reduction gearing to a screw that runs the full length of the bed, the screw having a coarse-pitch left- and right-hand thread. Corresponding left- and right-hand nuts rotate on this screw and are connected to a lever at the front of the carriage. Moving this lever upward, produces motion in one direction, and moving it downward produces motion in the opposite direction. Combined with the rapid traverse movements, the lever also controls the longitudinal and cross feeds so that all power movements of the carriage are controlled through a single lever. Feeds are reversible by means of the lever at the bottom of the apron. The quick-change gear-box provides thirty-two feeds and threads, while sixteen additional feeds and threads may be obtained by varying the ratio of the gears at the headstock end of the lathe.

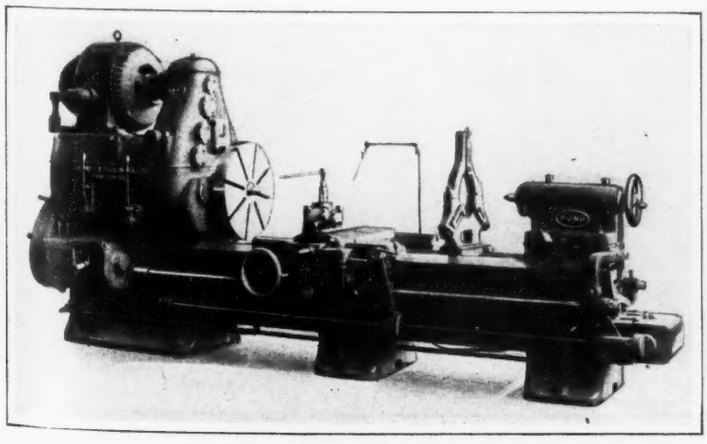


Fig. 2. Pond Improved "Time Saver" Lathe

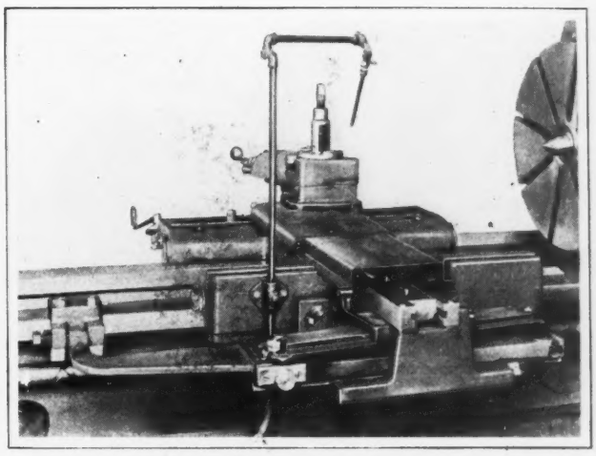


Fig. 3. Construction of Improved Taper Attachment

The taper attachment, which is shown in Fig. 3, is considerably more rigid than the superseded design. Tapers up to 3 inches per foot, either side of parallel, and up to 18 inches in length, may be turned with one setting.

This lathe is built in 27-, 30- and 36-inch sizes, with any desired bed length. The drive may be through a direct-current variable-speed motor as described, or through an alternating-current constant-speed motor or a single pulley.

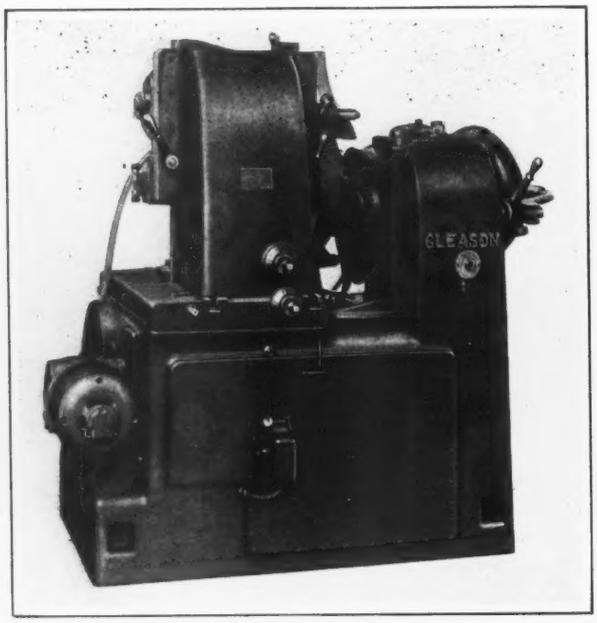
GLEASON SPIRAL BEVEL GEAR GENERATOR

Spiral bevel gears up to 10 inches pitch diameter can be cut on a production basis in a single-purpose machine recently designed by the Gleason Works, Rochester, N. Y. The design of this machine differs considerably from previous Gleason spiral bevel gear generators, but the same basic principle is used, the generating motion being obtained by means of a crown gear and segment. The unit carrying the cutter is given a lateral movement to clear the cutter while the blank is indexing. The cutter-spindle is mounted in ball bearings.

An important feature of the machine is the elimination of many moving parts by the use of three motors, there being one for the cutter drive, another for producing the feed and generating motion, and a third for the index. An automatic controller and push-button control station with start, stop, and jog positions are required for the first two motors, while the index motor is direct connected and runs continually. The first two motors are automatically stopped when the gear has been completed, which permits one operator to handle several machines.

With the exception of a few easily accessible hand-oilers that require but infrequent attention, the machine is automatically lubricated. Chips drop into a basket which is tipped into another basket when full. The second basket can be removed when the machine is in operation, without interfering with the operator. Cutting oil and lubricating oil are replenished from the rear.

The machine is compact, occupying a



Gleason Manufacturing-type Spiral Bevel Gear Generator

space of only 5 feet 7 inches by 3 feet 10 inches, and can be arranged in battery formation by using spacers to join several machines. Two work-carrying heads may be supplied, one of these being for gears of greater pitch angles than 63 degrees 26 minutes and the other for pinions of lesser pitch angles than 26 degrees 34 minutes. The standard equipment includes a segment for one gear or pinion only, but the cutting of a variety of gears or pinions can be arranged for when the machine is built.

ACME HEAVY-TYPE UNIVERSAL TURRET LATHE

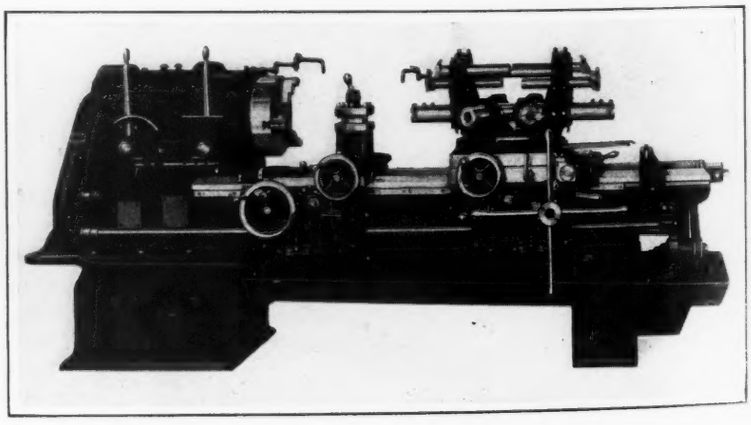
A heavy type universal turret lathe equipped with a "Duo" control has been added to the line built by the Acme Machine Tool Co., Cincinnati, Ohio. This machine was shown at the Cleveland Exposition. It has a 4 1/2-inch bar capacity, and will swing work up to 17 inches in diameter over the side carriage bridge and 25 inches in diameter over the bed. The main turret has a travel of 44 inches.

The all-geared head has a single pulley drive. All transmission shafts in the head are mounted in Timken tapered roller bearings. Sliding gears provide nine forward and reverse spindle speeds. All speed changes, both forward and reverse, and stopping, are made through two interlocking levers located at the front of the head. A multiple disk clutch on the initial drive shaft transmits power to the gearing. This clutch is automatically disengaged when changing speeds. An outboard ball-bearing support is provided for the driving pulley. The spindle driving gear is located close to the front bearing, and there are no rotating gears on the spindle. End thrust of the spindle is taken by a ball bearing. A splash system of lubrication supplies ample oil to all bearings.

The motor is placed in the cabinet type leg and connected to the driving pulley by means of a belt or chain. Each of the two carriage aprons contains a separate sliding-gear transmission, which provides twelve independent feed changes for each carriage. Both mechanisms revolve in oil, and the shafts revolve in ball bearings. With all feed changes located in the aprons, there are only two points of control, and it is unnecessary for the operator to move from his normal position to make speed or feed changes.

The side carriage spans the bed ways, so that there is no overhang of the square turret and tools. This carriage clears the chuck and can be moved out of the way to permit bringing the flat turret close to the chuck. The main turret revolves on a tapered stem of large diameter, and is automatically locked in position by means of a taper plunger. It is further held down at the extreme outer edge by circular clamps.

The cross-slide can be operated in both directions by hand or power, an adjustable device furnishing a positive means for locating the turret on center. A flat turret is regularly furnished, but a hollow hexagon turret can also be supplied. A taper attachment for turning tapers up to 3 inches per foot, and a chasing attachment are also available. The weight of the plain machine is approximately 8500 pounds.

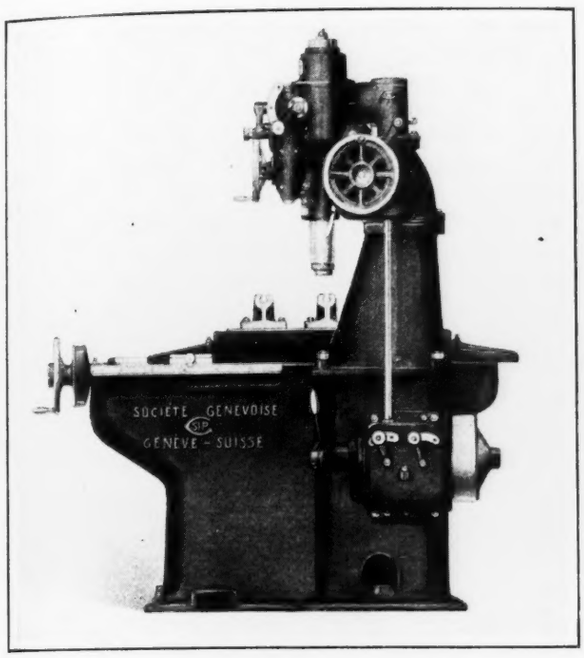


Acme Heavy-type Turret Lathe with "Duo" Control

SOCIETE GENEVOISE JIG BORING MACHINE

A No. 3 jig boring machine is being placed on the American market by the Société Genevoise d'Instruments de Physique, Geneva, Switzerland, through the R. Y. Ferner Co., Investment Bldg., Washington, D. C. This machine is midway in capacity between the Nos. 2 and 4 machines built by the same concern. Like the larger machines, the new one has a table that moves on ways on the bed, uprights on each side of the table which are connected by a cross-rail, and a boring head mounted on a slide which moves on the cross-rail. The cross-rail, however, differs from that of the larger machines in that it is not raised and lowered, but rigidly connects the uprights. The machine is intended to meet the requirements of the smaller contract shops and manufacturing plants.

The table measures 16 by 24 inches, and has a travel of 16 inches. The cross-travel of the spindle



Societe Genevoise Jig Borer with Stationary Cross-rail

slide is 12 inches. The maximum height of the boring head above the table is 12 inches, but as the feed of the spindle is 6 1/2 inches, it is possible to bring a drill or boring tool quite close to the table. For flat work, two cross-rails are provided, which can be attached to the table top by means of clamps. The flat pieces may be mounted on these rails to bring them within the range of the tools.

The principles of measurement are the same as those of previous jig boring machines built by the company, accurate micrometer screws which automatically compensate for errors being used. The screws have ten threads per inch, and the micrometer heads are graduated to 0.0005 inch and are read by means of verniers to 0.00005 inch.

The maximum drilling capacity of the machine in soft steel is 1 inch, and in cast iron, 1 1/2 inches, while the maximum boring capacity is 4 inches. Three automatic spindle feeds are provided, namely, 0.003, 0.005, and 0.008 inch per revolution, respectively. Four speeds of 75, 150, 300, and 600 revolutions per minute are obtainable through a gear-box driven by a single pulley. Bosses are provided on the left-hand side of the machine for mounting a motor with the belt extending across the back of the machine and protected by a cast-iron cover.

A special circular table is provided when desired, while other accessories include a "broken" type of microscope which is mounted in the spindle, a centering dial indicator, and three adjustable boring tools. The machine weighs approximately 2650 pounds.

HENDEY CRANK SHAPER

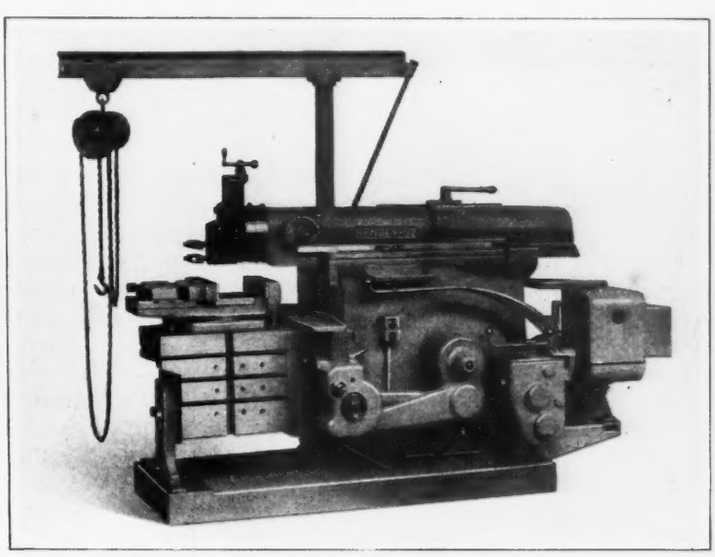
Automatic lubrication is one of the features of the 32-inch crank shaper presented at the Cleveland Show by the Hendey Machine Co., Torrington, Conn. The entire driving mechanism is automatically lubricated; the speed change gears run in oil circulating through the box; and the bull gear, driving pinion, and back-gearing are completely enclosed in a leak-proof compartment and run in an oil bath of forced circulation. Oil is also pumped to the sight-feed manifold, which is equipped with individual controls, and from there is distributed to the ram ways, rocker-arm ways and bearings, as well as to the feed mechanisms on the bull-gear horn and at the end of the cross-rail.

The driving mechanism is constructed as a unit with the speed gear-box, which is bolted to the right-hand side of the column. In this box there are two shafts running in ball or roller bearings, on which are mounted eight gears that provide four speed changes. The same shafts extend into the column and carry the back-gearing, one shaft extending through into engagement with the driving pulley or sprocket. The driving mechanism is completely assembled as a unit before it is placed in position.

Power transmission from the pulley to the shaft is accomplished through a Hendey patented combined friction clutch and brake, which is controlled by the long horizontal lever extending to the front of the machine. The friction clutch is of the self-energizing type which reacts against any tendency to slip by increasing its driving capacity.

The bull gear is of two-piece construction, and the hub is mounted in two Timken tapered roller bearings. The rocker arm is of double I-beam construction, and is pivoted in the base. This bottom pivoting neutralizes the tendency of the crank-pin to raise the arm on the first half of the cutting stroke and thus exert unnecessary pressure on the ram ways. The connecting link between the arm and the ram is of box form and, when in action, exerts a downward pull on the ram that tends to counteract the upward thrust of the cutting tool.

The cross-feed takes place on the reverse stroke only, and is of the slow motion type, functioning through the entire return stroke period without shock. All feed changes are made at the end of the cross-rail by means of a double-handle crank which controls a link motion. The feed can be changed



Hendey 32-inch Crank Shaper

while the machine is in operation. A large dial shows the feed changes in thousandths of an inch, the range being from 0.010 to 0.150 inch. The ball handle on top of the feed-case is used to engage, stop, and reverse the feed. Thrust and radial loads on the cross-feed screw are taken on a ball bearing, while a friction-controlled safety stop disengages the feed at each end of the cross-rail.

The table support has a new method of adjustment from the front. This mechanism consists of two racks having ratchet teeth and a wedge. One of the racks travels with the table, while the other has a floating connection with the brace. The wedge is operated by means of a hand-nut near the bottom of the brace. After the table has been brought into position, the wedge elevates the floating rack into contact with the other rack, and they are then bolted to the brace. The front of the brace travels on a shoe bolted to the shaper base.

A motor of either 10 or 15 horsepower capacity can be used for this shaper. It should be of the constant-speed type and run at from 1200 to 1800 revolutions per minute. The motor bracket is bolted to the column and to the base. A silent chain transmits power to the drive shaft.

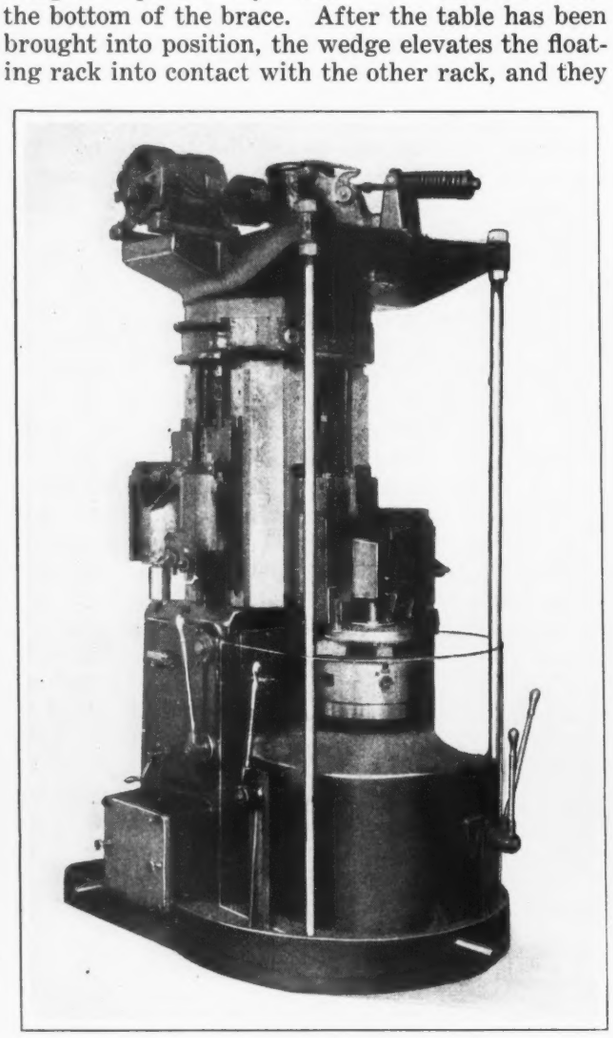


Fig. 1. Bullard Automatic Vertical Turret Lathe

BULLARD AUTOMATIC VERTICAL TURRET LATHE AND "CONTIN-U-MATIC"

An automatic vertical turret lathe of new design, intended for performing boring, turning, facing, and similar operations on small and intermediate quantities of work, was featured at the Cleveland Exposition by the Bullard Machine Tool Co., Bridgeport, Conn. This machine, which is shown in Fig. 1, incorporates a single-spindle unit with a monitor type of turret having four faces. Three of these faces are provided with tool-heads of the construction illustrated in Fig. 3, for taking multiple cuts, while the fourth face is plain and is presented to the spindle for the chucking operation. The three tool-heads offer a sequence of operations at independent rates of speed and feed. Automatic operation of the machine during the complete cycle permits an operator to supervise a number of machines, depending upon the time allowed for chucking.

Among the features particularly pointed out for this new turret lathe are ease of set-up and economy of tooling for smaller quantities of work and larger quantities of repetitive jobs that justify block type tooling. The machine can be quickly changed over from one job to another or to meet changes in parts.

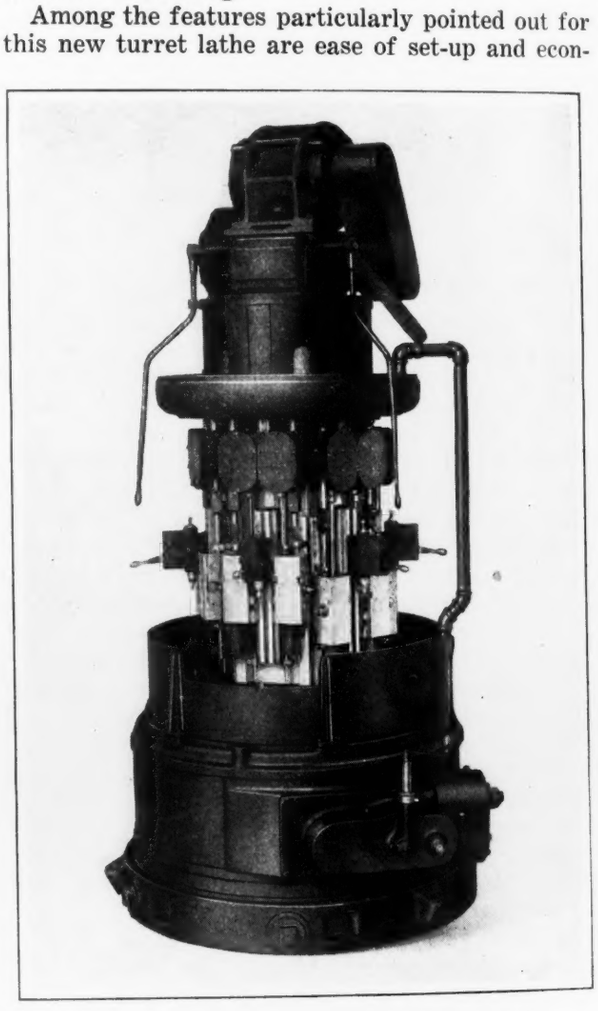


Fig. 2. Bullard "Contin-U-Matic" Center Lathe

At the head of the spindle is mounted a mechanically operated power chuck of three-jaw universal type in which the chucking pressure may be calibrated to suit the work. The chuck is operated from a unit in the base of the machine controlled by a lever. This chuck mechanism may also be used to actuate certain work-holding fixtures. Work up to 24 inches in diameter and 7 inches in height from the face of the chuck or 16 inches in diameter up to 15 3/4 inches high can be swung.

After the work has been chucked, the clutch mechanism is tripped by the operator, and then the turret indexes automatically until the cycle of operations has been completed and the plain turret face is again presented to the work-spindle. The tool-heads may be of plain, compound, universal, or double-purpose type, providing for vertical, horizontal, and angular feeds or a combination of vertical and horizontal feeds.

As the turret registers each tool-head in the working position, the feed mechanism is tripped. The tool-head then advances rapidly to the work and is locked in position, after which the tool-slide is fed to take the cut at the predetermined rate. The tools are then rapidly returned and the turret indexed. The spindle speed and the tool feed for each of the heads may be varied independently.

The unit that controls the spindle speed and the tool feed of each head is located in the base of the machine. Independent sets of quick change-gears provide three series of spindle speeds of nineteen changes each, the minimum speed of the first series being 7.4 revolutions per minute, and the maximum speed of the third series, 140 revolutions per minute. There are also three series of feeds having nineteen changes each, the minimum feed of the first series being 0.0041 inch per revolution, and the maximum feed of the third series, 0.1315 inch per revolution.

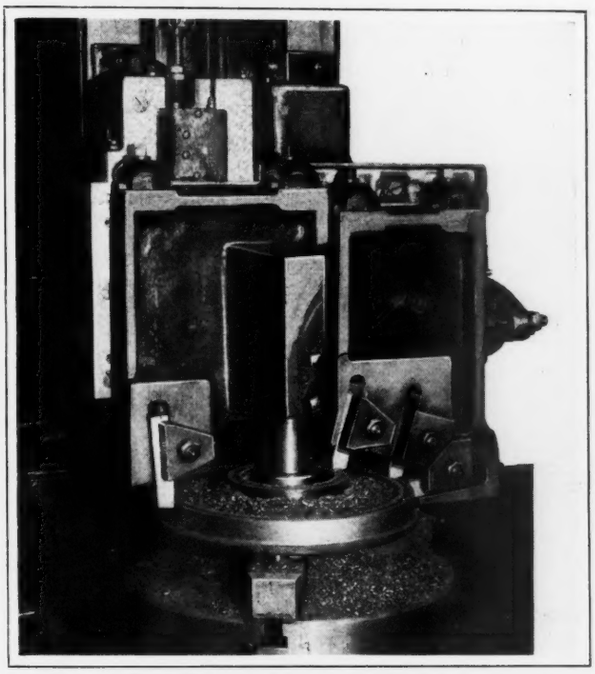


Fig. 3. Tool-head of Bullard Vertical Turret Lathe

Above the turret at the head of the column there is a supporting plate which forms the oil-distributing reservoir and a base for the bracket that supports the driving motor. Lubrication for the operating mechanism is accomplished by a flood of filtered oil fed by gravity from the distributing reservoir. Reservoirs for the lubricating oil and cutting compound and their pumps are contained in the base. External units which cannot be reached by the gravity lubricating system are lubricated by means of an Alemite Zerk pressure oil gun. The machine employs a 7 1/2-horsepower constant-speed motor running at approximately 1800 revolutions per minute, and weighs about 14,000 pounds.

Another machine exhibited at the Cleveland Show by the Bullard Machine Tool Co. was the 10-inch six-spindle "Contin-U-Matic" center lathe illustrated in Fig. 2. This is an automatic production machine of the continuous type for work that may be held vertically between centers. The basic principle is similar to that of the "Contin-U-Matic" chucking machine described in June, 1924, MACHINERY, which has six work-spindles in a carrier and six tool-heads mounted on a hexagonal column built integral with the carrier. The spindles and tool-heads always remain in the same relation to each other, and rotate slowly around the central column.

In the "Contin-U-Matic" center lathe, tailstocks with centers are mounted around the upper portion of the tool support column. The height of these centers may be varied to suit the length of work held. The standard maximum capacity between these centers and the chuck center is approximately 20 inches, but this may be increased by extending the height of the tool support column and other parts. Spindle speeds are available in a range up to 300 revolutions per minute. Any one set speed is common to all spindles. In work diameter, the machine has a maximum capacity of 9 1/4 inches swing under the tool-slides, while there is a maximum diameter clearance of 5 1/4 inches between the tool-slides.

All tool-heads are actuated by a cam mounted at the head of the machine, which provides a rapid advance of the heads to the point of cutting. There is then a period of feed at a predetermined rate, and finally, a rapid return with a short dwell at the high point to permit reloading. The primary feed motion from this cam is transmitted through secondary speed-boxes to the two tool-slides on the opposite sides of each center. These slides are independent in action, and are independently variable in respect to rate and length of the feed stroke.

A tool-slide traverse provides adaptability in taking vertical and horizontal cuts. Each slide may be set for either a plain vertical or a plain horizontal stroke with a rapid advance and a feed of predetermined rate and length. In combined motions, however, each slide advances horizontally to the work, traverses vertically while the cut is being taken, withdraws from the work at the bottom of the stroke, and returns rapidly to its original position. The maximum length of the plain vertical stroke is somewhat over 9 inches, while the maximum length of horizontal stroke is 1 3/4 inches.

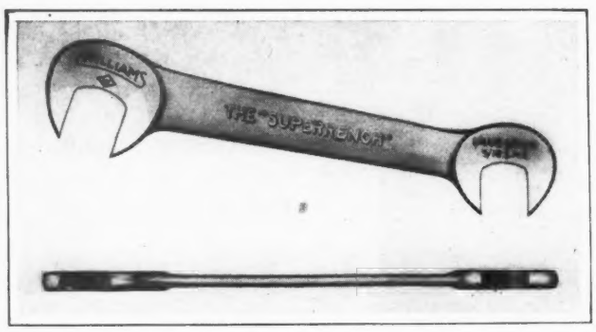
When necessary for the special holding of work, a power-operated mechanism can be provided for actuating the chuck or special work-holding fixtures. The tailstock is operated with one motion of the hand-lever. Independent tooling on the six individual units which comprise the machine makes it possible to vary the operation and even the nature of the work, so that a variety of jobs can be run at the same time, provided the common features of spindle speed and primary tool-head traverse are adaptable to all operations.

Lubrication of the machine is assured by a constant flow of oil to all operating parts within the machine, and by a pressure lubrication system to all external units for which a constant flow cannot be provided. Cutting compound is constantly circulated from the base to a distribution trough at the head of the machine and then to the tools. The power requirements of the machine range from 10 to 20 horsepower, a constant-speed motor for operation on either alternating or direct current being suitable. The approximate weight of the machine is 22,500 pounds.

WILLIAMS "OBSTRUCTION SUPERRENCH"

Many machines, automobiles, and motor trucks have awkwardly placed nuts and bolts which are inaccessible with ordinary wrenches. For loosening and tightening such bolts or nuts, J. H. Williams & Co., Buffalo, N. Y., have brought out a new "Obstruction Superrench." This wrench has narrow pointed jaws, thin heads and openings which are at an angle of 75 degrees in relation to the center line of the wrench.

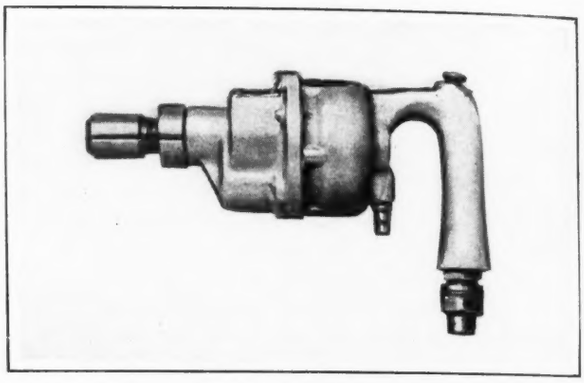
The jaws of both heads project from the same side of the handle so that the jaw at the end being gripped always extends away from the palm of the user, thus providing a comfortable grip. When used in the natural manner to obtain a comfortable grip, the strength of the wrench is considerably greater than that of the conventional type, because the jaw that receives the strain near its point, is reinforced by the handle. This new wrench is furnished in a wide variety of sizes for all U. S. and S. A. E. standard nuts and cap-screws. Like all "Superrenches" made by this company, it is forged from chrome-molybdenum steel.



Williams "Superrench" for Reaching Inaccessible Bolts and Nuts

BUCKEYE AUTOMATIC SCREWDRIVER

A portable automatic air-operated type screwdriver is being introduced to the trade by the Buckeye Portable Tool Co., 131-135 Wayne Ave., Dayton, Ohio. It is mentioned that this tool is capable of driving a No. 15 screw 3 1/2 inches long into yellow pine filled with pitch, without previous tap-hole drilling. It may also be used for driving cap- and set-screws, for setting nuts, etc.



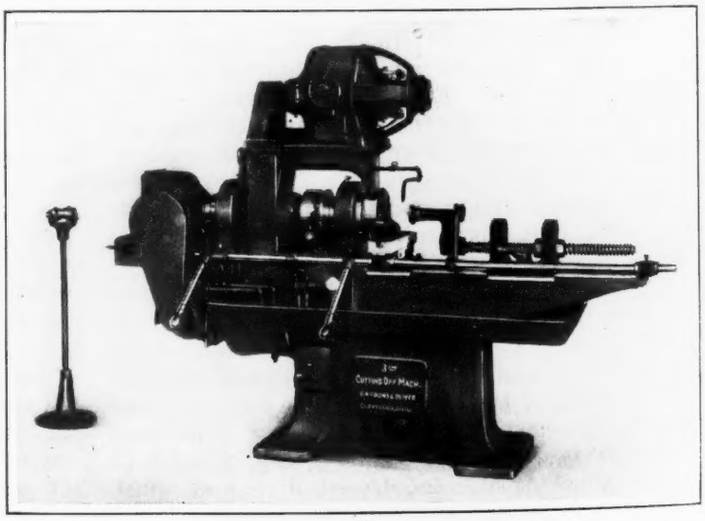
Buckeye Portable Automatic Screwdriver

Ball bearings are supplied throughout, and there are no valves in the tool itself. A button throttle control is provided. The device is of a rotor construction, the four blades of the rotor being the only parts subject to wear. The length of this tool over all is 10 inches; the length of the main body, 6 inches; the largest diameter, 3 5/8 inches; and the weight, 5 3/8 pounds. It is furnished with a quick-change chuck having an 0.625-inch diameter hole with a square bottom to provide for driving collets.

BARDONS & OLIVER CUTTING-OFF MACHINES

Machines of 1 1/2- and 3-inch capacities have been brought out by Bardons & Oliver, Cleveland, Ohio, for cutting off bar stock and tubing. These machines are operated through their entire cycles by imparting one movement to the hand-lever. On average work, not more than from three to five seconds is required for opening the chuck, feeding the bar or tube, closing the chuck, and bringing the tool back into the cutting position. From six to ten cuts can be taken per minute, depending upon the nature of the material and the length of the pieces.

The spindle runs in Timken tapered roller bearings. An air-operated collet form of chuck is used, the master collet being of hinged design. False jaws for different sizes of stock are readily changed without removing the collet from the spindle.



Bardons & Oliver Cutting-off Machine

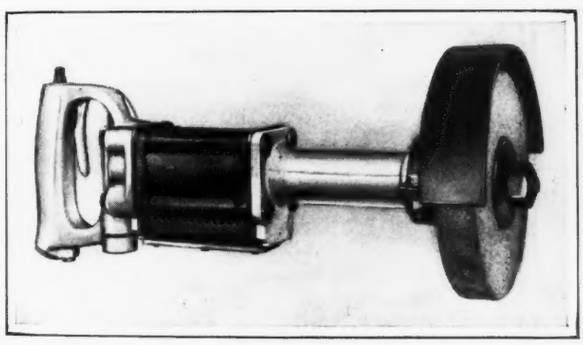
Opening and closing of the collet are controlled through a valve located on the front of the head. This valve is operated by means of a short arm on the shaft which carries the hand-lever and cross-feed pinion.

The cut-off slide is regularly equipped with a tool-holder carrying a high-speed cutting-off blade, but multiple tool-holders can be furnished if desired. The roller feed is driven by a 1/2-horsepower motor, the rolls being in constant motion. Further movement of the hand-lever after closing the collet, brings the feed rolls into contact with the stock, thus almost instantly advancing the stock against the adjustable stop. By a link connection with the lever shaft, the stop is automatically withdrawn from contact with the end of the stock just before the tool starts cutting.

The main driving motor is of three-horsepower capacity and is mounted on a tilting table directly over the spindle. It is connected with the spindle by means of sprockets and a silent chain. Using the regular stop, work up to 5 feet in length can be cut in both machines.

ROTOR AIR GRINDER

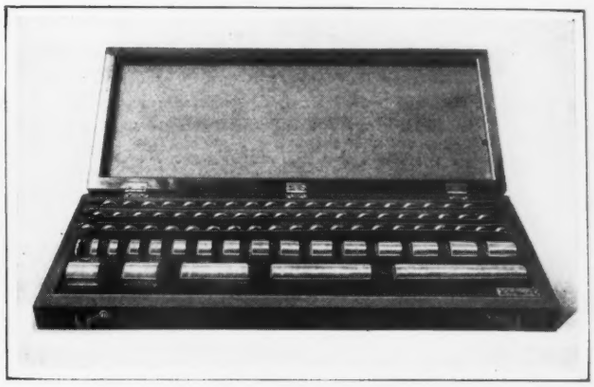
A model D-1 portable air-driven grinder has recently been brought out by the Rotor Air Tool Co., 5905 Carnegie Ave., Cleveland, Ohio, for use with



Rotor Air Grinder which Operates at High Speeds

rubber-bonded "Redmanol" or bakelite wheels exclusively. It is claimed that this grinder has ample power for maintaining a speed of 5400 revolutions per minute under load, which gives a surface speed of 8500 feet per minute. The free speed without load is controlled by a quick-acting governor, which cuts off the air at 5800 revolutions per minute.

This grinder has two rotors which do not touch the cylinder, operating in a film of oil. The spindle runs in ball bearings. The exhaust and inlet sides are sealed by a fiber blade which rides on the chrome-nickel steel rotor. This design concentrates wear on the fiber blade, and this part can be replaced in five minutes.



Van Keuren "Microgage" Set

VAN KEUREN "MICROGAGES"

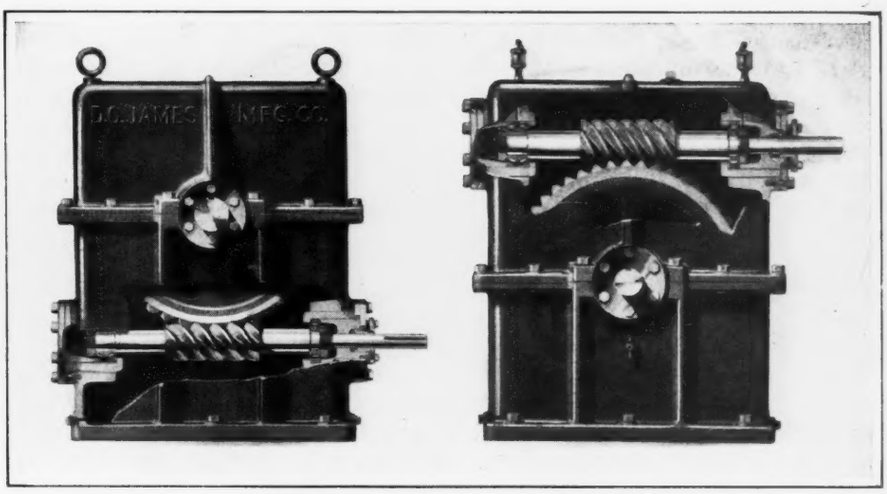
A set of "Microgages" or gage-blocks which includes the sizes of the 81 block series ranging from 0.050 inch to 4 inches, has been placed on the market by the Van Keuren Co., 12 Copeland St., Watertown, Boston 72, Mass. This set makes possible any combination in ten-thousandths inch, from 0.200 inch up, within the range of the set.

These "Microgages" are manufactured with a wear allowance, being held within a tolerance of minus zero and plus twenty-five millionths inch. This leaves an average wear allowance of about fifteen millionths inch, so that the gages may be used on production work on grinding and similar precision machines.

JAMES WORM-GEAR SPEED REDUCERS

Heavy-duty worm-gear speed reducers of the construction illustrated have recently been added to the line of speed reducing units built by the D. O. James Mfg. Co., 1114 W. Monroe St., Chicago, Ill. In these reducers there are large oil cooling chambers which prevent overheating. When the worm is located at the top of the unit, as shown at the right, sight-feed cups furnish oil to the roller bearings on the worm shafts. An oil level cock prevents over-oiling, and a drain plug in the lower part of the housing facilitates draining off the oil.

The gears are made of phosphor-bronze, and the worms of chrome-nickel steel. Timken and Norma-

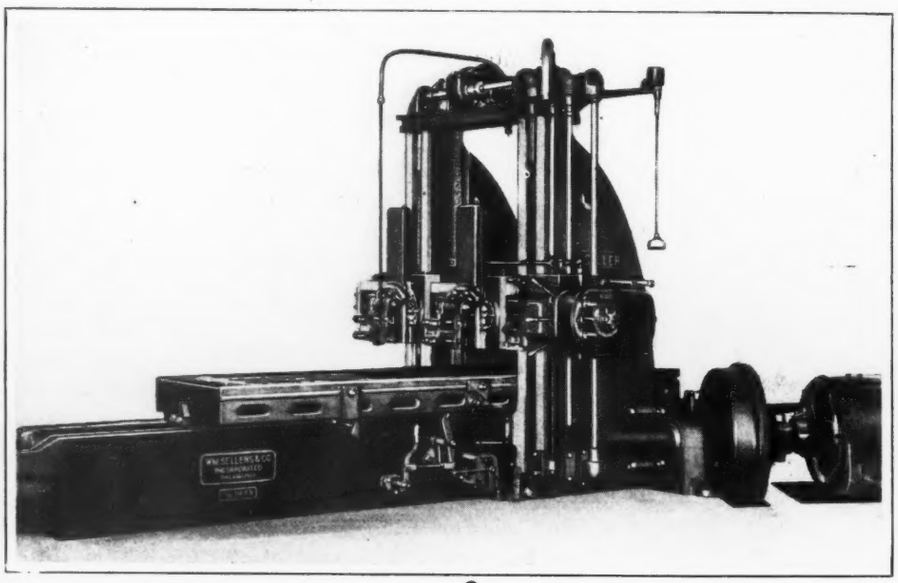


James Heavy-duty Worm-gear Speed Reducers

Hoffmann roller bearings are used, as well as interchangeable bushings. A lock-nut and pin, which permit easy adjustment, hold the thrust bearing in the proper position on the worm shaft. The stuffing gland on the worm shaft can be repacked without disturbing the shaft.

SELLERS TYPE K PLANER

The type K planer recently developed by William Sellers & Co., Inc., Philadelphia, Pa., which was briefly described in September MACHINERY, is shown in the accompanying illustration. This planer is built in the 36- by 36-inch size and larger, with a bed made in lengths to suit requirements. It combines certain basic Sellers principles with various modern improvements. All controls are grouped advantageously on the right-hand side, except in the case of the left-hand side-head. Wherever desirable, oil is supplied under pressure through individual pipes, and where not much oil is required, lubricant is supplied by wicks extending through pipes from reservoirs.



Sellers Type K Planer

The machine is equipped with the Sellers drive in which there is but one shaft running through the bed and but one gear—a spiral pinion—located between the ways. A reversing motor, on the right-hand side of the machine at the rear, furnishes power. There is one reduction between the motor and the spiral-pinion driving shaft, this reduction consisting of a herringbone gear and pinion running in oil. The spiral pinion is so designed that four teeth are always in contact with the rack, and the angle of the rack is such that no side pressure is developed from the pinion. Step bearings adjustable from outside the bed take the thrust from the spiral pinion. Oil is circulated continually through these thrust bearings.

The cross-rail is clamped to the uprights close to the work by a single lever at the right-hand side of the machine. Two heads are usually provided on the cross-rail and a side-head on each upright. The saddle, slides, etc., have been entirely redesigned, and a power traverse is supplied for all heads. The bed has one flat and one double V-way, the double vee being provided to maintain accuracy under the heaviest side cuts.

An ample supply of oil is furnished to the ways from a pump driven by a separate motor. This pump always begins running before the table starts, so as to insure satisfactory lubrication even after the machine has been standing idle for a period. The pressure of the oil is sufficient to force it through the grooves for the full length of the table. It is collected at the ends of the bed and filtered before being returned to the tank.

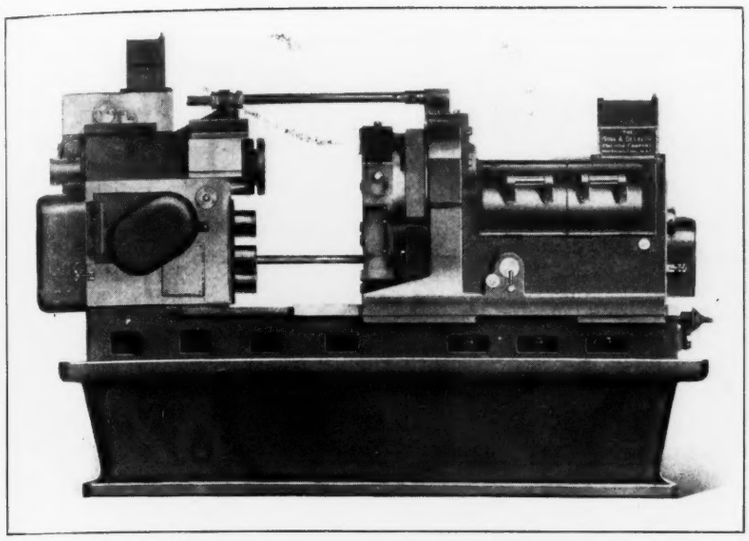
Levers for selecting various feed motions are located at the end of the cross-rail. To change from feed to traverse, it is necessary to move one lever only, and one head can be traversed while another is being fed. Accurate setting of the heads is facilitated by micrometer dials. The feeding mechanism is driven by a separate motor, which does not run continuously but is started and stopped as required. The traverse is accomplished by means of another motor which starts up whenever the traverse clutches are engaged. The mechanism is so arranged that it is impossible to engage the feed and traverse on the same head simultaneously.

The tool-slide is of the outside type. The length of bearing between the slide and the swivel that carries it remains constant for a long or short overhang. The vertical feed-screw is equipped with a ball thrust bearing, and tapered gibs are furnished for all slides. Lubrication is supplied from a central reservoir. The side-heads are so attached to the uprights that they can be removed at any point.

GOSS & DE LEEUW AUTOMATIC CHUCKING MACHINE

A four-spindle automatic chucking machine which accommodates work up to 10 7/8 inches in diameter by 10 inches in length has recently been developed by the Goss & De Leeuw Machine Co., New Britain, Conn. This machine is known as the 11- by 10-inch size. The cutting tools revolve, while the work is held on a turret and fed to the tools. Two-jaw chucks are generally employed for holding the work, but three- or four-jaw universal chucks can also be furnished, as well as special fixtures and draw-back arbor attachments. Turning, boring, drilling, reaming, facing, and threading operations can be performed at high production rates. Oil-grooving, both straight and spiral, and light broaching can also be done.

This machine is particularly adapted for handling such parts as end covers of fractional-horsepower motors, door-check casings, valve fittings



Goss & De Leeuw Automatic Chucking Machine

and bodies up to the 3 1/2-inch size, automobile parts, electric drill casings and railway parts. The return stroke of the feed cam, the index time, the advance stroke of the turret up to the feeding section, and the speed of the cutting solution pump remain constant no matter at what speed the machine is operated.

The tool-spindles are driven through individual change-gears. In setting up the machine, the operator determines the best speed for each spindle and installs gears to give this speed. The machine is also provided with a set of main change-gears, by means of which the speeds of Nos. 1, 2, and 3 spindles can be increased as a whole for brass work, or decreased for harder materials, such as cast iron and steel.

All threading operations are accomplished with the No. 4 spindle, which is mounted in a separate slide, and are controlled by the Goss & De Leeuw patented lead-screw arrangement. The lead-screws and nuts are quickly changed for various pitches of threads, and both inside and outside threads of different pitches can be cut at the same time. The threading spindle is fitted with a safety clutch, which protects the tools should a tap or die bottom in work due to incorrect setting.

The turret and turret-slide are fed by a cam, moving forward and backward as a unit. Indexing of the turret is accomplished through a Geneva stop motion. The cam drum is mounted in the slide and is used only for feeding and returning the slide. This necessarily makes the diameter of the cam small and does away with idle space, the cam using all but 1 inch of the entire circumference. The cam stands still while indexing takes place. Interchangeable feed cams can be furnished for use when several parts are manufactured on the same machine, so that different feed strokes may be obtained.

The cam roller is mounted on a slide between the main ways of the machine, and is locked firmly to the bed during all machining operations. Positioning of this slide accurately locates the turret. A screw with a micrometer collar acts directly on the roll slide and permits accurate adjustments. This feature is of especial value when accurate facing must be done, and also permits the rapid final adjustment of work after a trial cut has been taken.

A pan for catching drippings of oil extends completely around the bed, and a separate pan at the rear catches chips which are delivered to it through an opening directly under the tools. When coolant is used, this chips pan also serves as a coolant reservoir.

A safety attachment incorporated in the machine gives confidence to the operator and makes it possible for one man to run two or more machines. A universal cross-cut attachment can be supplied for such operations as necking in back of threads, light-forming and single-point facing. The machine is arranged for motor drive only, with the motor mounted on a base separate from the machine. To facilitate setting up, the machine may be hand fed by applying a crank-handle wrench. The power feed can be engaged or disengaged from the front or back of the machine. The net weight of the machine is about 13,000 pounds.

BRIDGEPORT HYDRAULIC FACE GRINDER

A type 94 heavy-duty face grinding machine equipped with a hydraulic table drive and wheel feed constitutes the latest development of the Bridgeport Safety Emery Wheel Co., Inc., 1283 West Broad St., Bridgeport, Conn. With this hydraulic equipment, any table speed from 0 to 85 feet per minute is available, as well as any automatic feed from 0.00025 to 0.010 inch. The feed is adjustable in quarter-thousandths of an inch and is indicated on a dial. In addition to the hydraulic

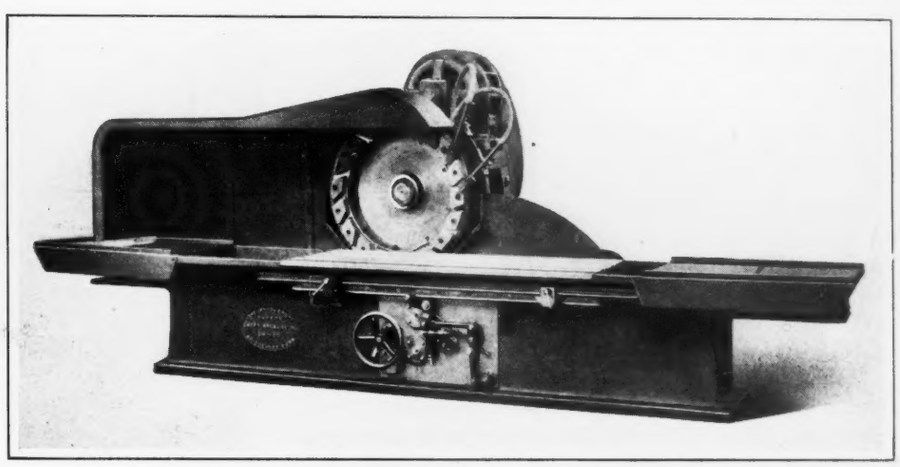


Fig. 1. Bridgeport Face Grinding Machine with Hydraulic Table Drive and Wheel Feed

feed, the wheel may be fed up or back by hand, the amount of hand feed being also shown on the dial. All controls of the machine are grouped about the operating position. There is a foot-treadle carriage reversal.

The spindle has an automatic take-up for end play, and is positively lubricated. It is equipped with radial and combined thrust and radial ball bearings. There is also a quick-acting brake. The spindle has a speed of 400 revolutions per minute. The grinding wheel is of the sectional type and is the 42-inch size. Water is supplied to the grinding wheel by a centrifugal pump through two one-inch pipes.

When the main driving motor is furnished for operation on alternating current, either a 60- or a 75-horsepower motor is used, and when it is furnished for direct current, the motor is of 60 horsepower capacity. The carriage driving motor has

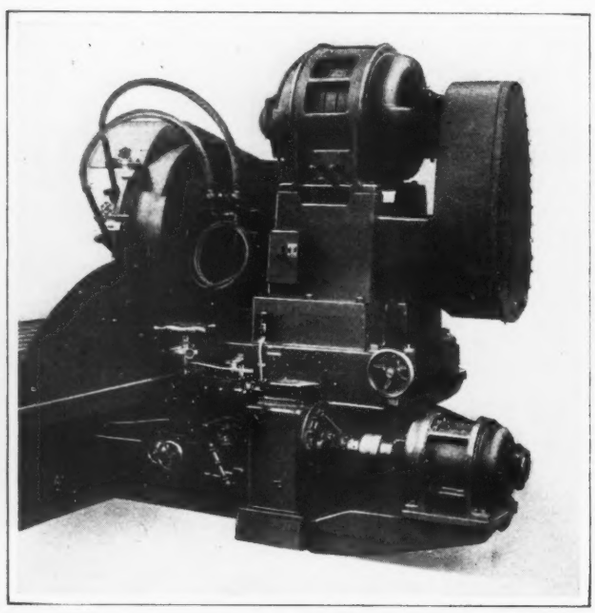


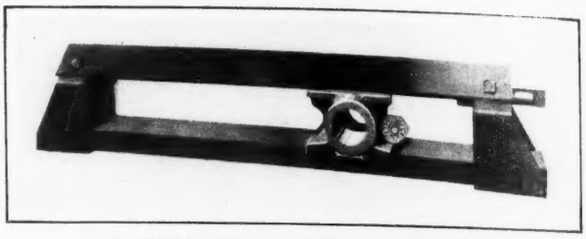
Fig. 2. Arrangement of the Hydraulic Equipment

a 7 1/2-horsepower rating, while the pump motor is of 1-horsepower capacity. The maximum length of work which can be handled is 86 inches, and the maximum height, 33 inches. The total length of the table, without the sheet-iron pans, is 12 feet 8 inches. This machine weighs approximately 23,000 pounds.

LINK-BELT TAKE-UP FOR CONVEYOR INSTALLATIONS

A "Protected-Screw" type of take-up, known as style DS, has been brought out by the Link-Belt Co., 300 W. Pershing Road, Chicago, Ill., for use in conveyor and similar installations. This take-up is made in many sizes and with various lengths of bearing movement. The diameter of screws, length of bearings, strength of frames, etc., are all proportioned to the size of the shaft and the length of bearing movement.

The frame is made of welded structural steel with a channel base welded to ends formed of steel plates in which the adjusting screw is mounted. The screw remains fixed in position, the nut used for adjusting the bearing traveling along the



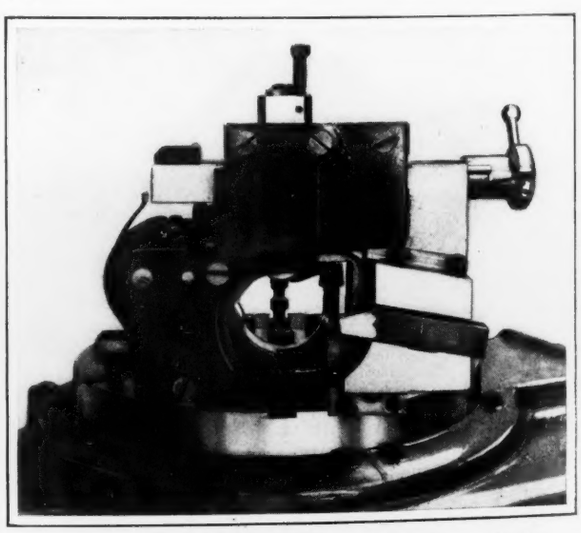
Link-Belt "Protected-Screw" Take-up

screw. The screw does not project beyond the ends of the frame or require additional space or a special frame construction. The bearing is made of cast iron, lined with babbitt and tapped for a grease cup or lubricant pressure fitting.

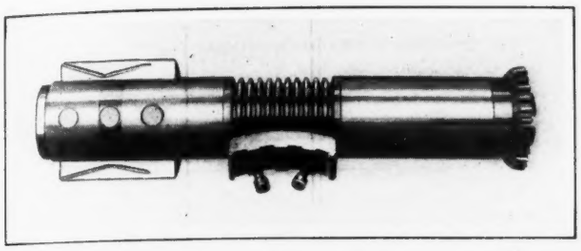
JONES & LAMSON TAPER TURNER

A taper turner designed to be used in two ways has been brought out by the Jones & Lamson Machine Co., Springfield, Vt., for application to the flat turret lathes built by this concern. The device may be used, first, in turning tapers from rough bar stock, in which case the cutter precedes the rolls; and, second, in turning tapers from finished stock or after a bar has been turned straight, in which case the rolls precede the cutter and bear upon the previously finished surface. The templet of this new M turner is of the same size and shape as that used on the model K taper turner. It should be about 2 inches longer than the length of the cut, so that the end can be pointed to make it enter easily. The angle of taper on the templet should be one-half the included angle of the taper on the work.

As illustrated, the device is set up to turn tapers from rough bar stock, and the rolls follow the cutter. For this work, a cutter made of 1-inch square stock is used. The cutting point should protrude about 1 1/16 inches from the cutter-slide and should be just high enough to be at the center of the work. Adjustments for height of the cutter are made by means of the screw directly beneath. After the cutter has been positioned, the rolls are adjusted to it. In using the turner for cutting tapers with the rolls preceding the cutter, it is necessary to use a cutter made of 1/2- by 1-inch stock.



Taper Turner for Jones & Lamson Flat Turret Lathes



Cutter-spindle of New High-speed Fellows Gear Shaper

FELLOWS HIGH-SPEED GEAR SHAPER

A high-speed gear shaper having a 2-inch stroke, designed for cutting gears up to and including 5/7 diametral pitch, has recently been placed on the market by the Fellows Gear Shaper Co., 78 River St., Springfield, Vt. With the exception of the capacity and the changes in construction which will be mentioned later, this machine is identical to the one described in considerable detail in January, 1922, MACHINERY. On the new machine the cutter-spindle is constructed in one piece and is made hollow in order to reduce the weight. The construction of this spindle may be seen from the illustration.

There is a new arrangement for attaching the guides to the spindle so as to obtain a better control. A larger spindle diameter increases the bearing surface and the life of the part. This spindle is arranged to carry 4-inch pitch diameter cutters only, having a 1 3/4-inch hole. The entire driving mechanism of the machine has been strengthened, the driving pulleys being 15 inches in diameter instead of 10, and also of wider face. The connecting-rod, operating rod, etc., are stronger, and a new apron has been added. Gears up to 7 inches pitch diameter, 2 inches face width and of 5/7 diametral pitch may be cut.

SKINNER STOCK RACKS

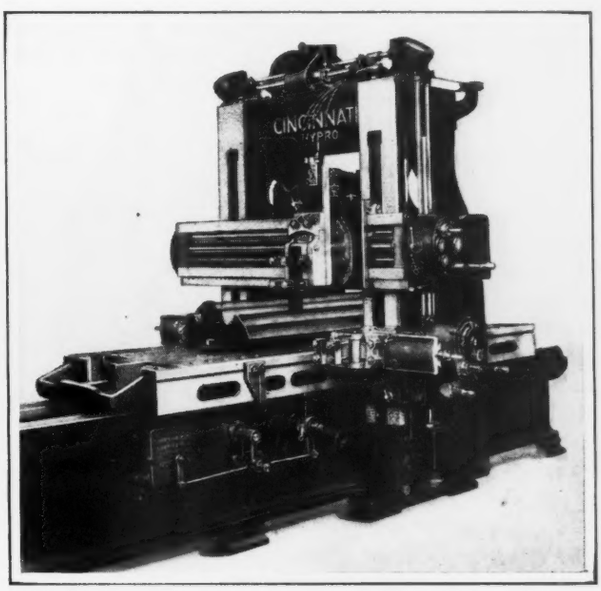
Sectional stock racks now manufactured by the Skinner Chuck Co., New Britain, Conn., are shown in the accompanying illustration. These racks may be conveniently placed back to back to facilitate the storage of parts. It is an easy matter to increase the drawer capacity at any time by simply adding new sections. The braces are made of cast iron. A locking device is provided, so that different rack sections can be readily assembled with stove bolts.

Skinner Sectional Stock Racks

ELECTRICAL PLANER-TOOL CONTROL FOR IRREGULAR WORK

Work of irregular outline can be accurately planed by means of an electrical tool control which may be provided on the "Hypro" planers built by the Cincinnati Planer Co., Cincinnati, Ohio. This electrical control is made by the Keller Mechanical Engineering Corporation, Brooklyn, N. Y., and is the same in principle as that provided on the die-sinking machines built by this company.

A templet made of sheet brass, 1/16 inch thick, of the same outline as the surface to be planed, is fastened to the rail in back of the slide. On the back of the slide there is also a carrier for a tracer which contacts with the templet. This tracer does not sustain the weight of the slide nor the pressure of the tool in any way. Contact between the tracer and the templet actuates the electrical mechanism, causing the tool to machine the work to the same outline as the templet. Work may be planed to small radii.



Cincinnati Planer Equipped for Automatically Machining Irregular Work

Inside of the cover at the right-hand end of the rail there is a magnetic gear-box which causes the rail screw to revolve backward or forward as required in the operation. A duplicate magnetic gear-box is mounted on the left-hand end of the rail for operating the feed-rod in the center of the rail, thus producing the required up and down movements of the slide. With this arrangement, the head movements along the rail or the vertical movements of the slide are performed automatically.

After a cut has been taken across the entire job, the tracer can be withdrawn from the templet and the head run back to the starting position by the rapid traverse which is regularly supplied on "Hypro" planers. By means of an adjustment, the tracer can be moved up or down the necessary

amount to plane off the work. A planer provided with this equipment may be used in machining drawing and drop-forge dies having surfaces of two or three different angles. It is mentioned that both the male and female parts can be so machined that they will go together satisfactorily without requiring hand fitting.

"AMMCO" AUTOMOTIVE TOOLS

Several tools recently brought out by the Automotive Maintenance Machinery Co., 549 W. Washington St., Chicago, Ill., are shown in the accompanying illustrations. Fig. 1 shows a tool intended for re-turning worn, tapered, or out-of-round crankpins without removing the crankshaft from the engine. In using this device, a helper turns the crankshaft by means of the starting crank, and the mechanic merely holds the tool in position on the pin. The tool generates a round crankpin, because the pin must pass through the fixed distance (indicated by the dotted line) between the cutting blade and the opposite supporting point of the jaw. It generates a straight and parallel crankpin, because the blade is held parallel to the jaw. The cutting blade is gradually advanced by turning the knurled adjusting knob.

In Fig. 2 are shown two cylinder grinders. The rigid tool, at the left, has five stones which must be reset during an operation as the cylinder bore becomes larger, whereas the four stones of the reconditioning tool, at the right, may be set to the diameter wanted before the operation is started. It can then be collapsed by hand or by using the collapsing trigger, and inserted in the bore to be finished. The collapsing trigger is next released, after which springs keep the four stones tight against the cylinder wall, and the tool expands as the bore becomes larger, until the desired diameter has been obtained.

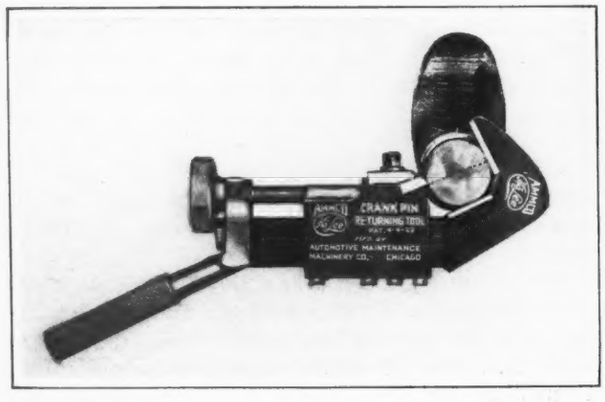


Fig. 1. "Ammco" Crankpin Re-turning Tool

Fig. 3. Reamer for Connecting-rod Bearings

With four sets of stone carriers, the rigid tool at the left is adaptable to all bores from 2 5/8 to 4 1/2 inches in diameter. The rigid tool may be operated by any 5/8-inch portable electric drill, and the reconditioning tool by any 1/2-inch portable electric drill.

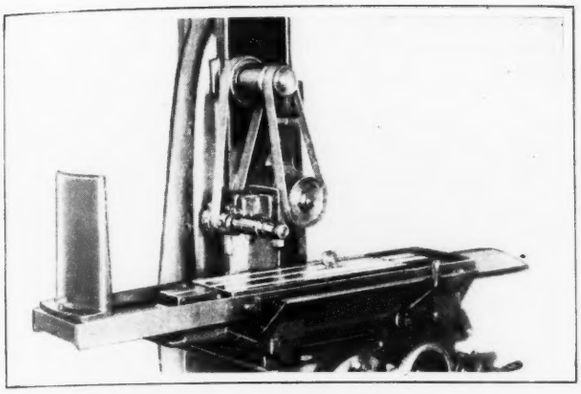
Fig. 2. Two Styles of Cylinder Grinding Tools

Fig. 3 shows a reamer for connecting-rod bearings, which is manufactured for all makes of cars in standard sizes, as well as 0.005, 0.010 and 0.020 inch under size. Reamers 0.002 inch over size are also available. A separate reamer is required for each size of bearing. This reamer consists essentially of an accurately ground body equipped with a cutting blade that is locked in a slot with a tapered gib. The reamer body is ground to the flat diameter of the corresponding crankpin, and the cutting blade is set to project 0.001 inch, which is sufficient to allow for oil clearance between the bearing and the crankpin. The reamer blade is set at the factory, and is not readjusted except when reground.

BROWN & SHARPE SURFACE GRINDING ATTACHMENT

Improvements have recently been made by the Brown & Sharpe Mfg. Co., Providence, R. I., in the design of the high-speed surface grinding attachment made for use on the B. & S. No. 2 surface grinding machine. This attachment is designed for driving small grinding wheels from 3/8 to 1 1/4 inches in diameter at a high rate of speed. Slots and similar small surfaces, so located as to prevent the use of a large-diameter wheel, can be rapidly ground with the attachment.

In applying the attachment to the machine, the wheel guard of the machine is removed and the attachment arm is clamped in position on the wheel-head. This arm, extending upward, carries an adjustable bracket in which there is a countershaft. The grinding head is carried on the main portion of the attachment arm, with its spindle



Brown & Sharpe Surface Grinding Attachment

parallel to the machine spindle. Both the grinding head and the countershaft bracket are adjustable for belt stretch.

The attachment is driven from a pulley mounted on the machine spindle in place of the regular grinding wheel, power being delivered by means of a canvas belt to a pulley on the outer end of the countershaft. A second canvas belt transmits the power from a larger pulley on the opposite end of the countershaft to the grinding head. Grinding heads of different capacities and spindle speeds are available.

COCHRANE-BLY IMPROVED MACHINES

Three improved machines were exhibited by the Cochrane-Bly Co., Box 367, Rochester, N. Y., at the Cleveland Exposition. One of these was a No. 66 metal sawing machine of the same general design as that described in October, 1924, MACHINERY. However, the improved machine gives three cutting speeds of 45, 60, and 75 feet per minute. The speed changes are made through sliding gears. The drive shaft runs in ring oiling bearings, while the friction clutch hub is provided with a self-oiling bushing and a reservoir of oil that is sufficient to last for several weeks. The machine is provided with a range of feeds from 3/4 inch to about 9 inches per minute.

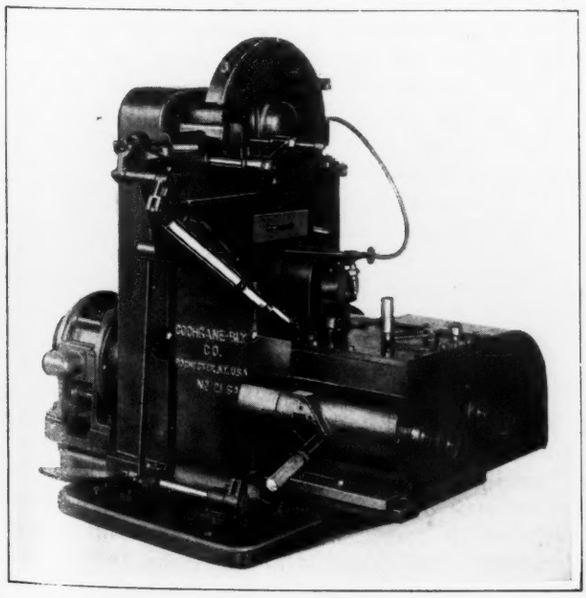


Fig. 1. Cochrane-Bly Semi-automatic Cut-off Saw

The second machine was a No. 21 semi-automatic high-speed cut-off saw designed for cutting non-ferrous metals and light gages of steel, tubing, shapes, etc. This machine, which is illustrated in Fig. 1, follows the design of a machine described in October, 1925, MACHINERY. It is provided with a quick-change gear-box, which gives six changes of speed ranging up to 50 strokes per minute, while change-gears permit an almost unlimited variety of speeds to be obtained. The gear-box contains a friction safety drive by means of which it is possible to regulate the pressure of the saw against the work.

This machine is operated through a positive pin clutch actuated by means of a foot-treadle. The latter can be locked for running continuously. The vise is automatic, opening and closing in time with the movement of the saw carriage to release the cut piece on the return stroke of the carriage and to permit feeding the bar through the gage before the next forward movement. A geared pump delivers cutting lubricant to the saw blade, and so the machine is arranged for either wet or dry grinding.

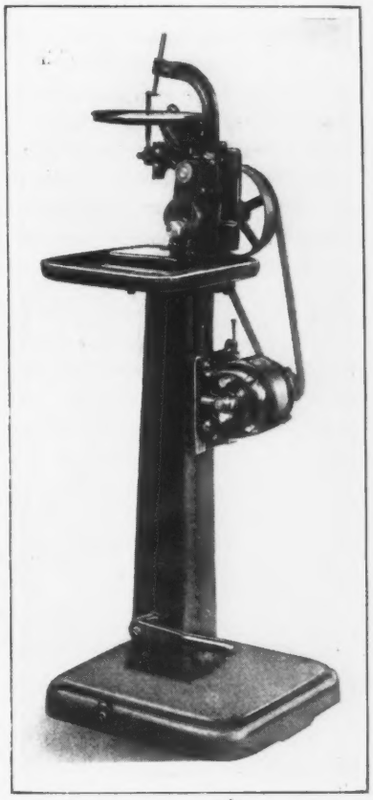
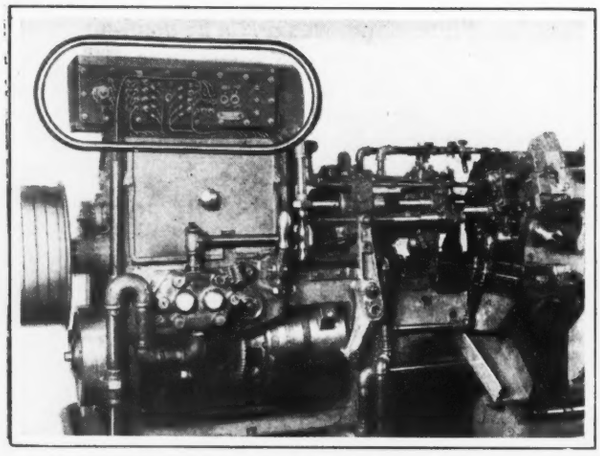


Fig. 2. Portable Filing Machine

The third machine exhibited was the No. 1 portable filing machine shown in Fig. 2. This machine is the Cochrane-Bly bench machine mounted on a pedestal having casters. An elevating device enables the column to be raised off the floor so that the machine can be easily moved to any convenient working position where it can be connected to a light socket.

MADISON-KIPP AUTOMATIC LUBRICATORS

Several automatic lubricators have recently been devised by the Madison-Kipp Corporation, Madison, Wis., for application to machines. The accompanying illustration shows a special type installed on a National Acme model C screw machine. This lubricator is an integral part of the motor base, whereas the conventional way of attaching a lubricator is to use an entirely separate tank furnished by the manufacturer of the lubricator. The lubricators are made inconspicuous by making the reservoir a part of the machine casting and submerging the lubricator mechanism into the reservoir. On the National Acme screw machine,



Madison-Kipp Lubricator on National Acme Screw Machine

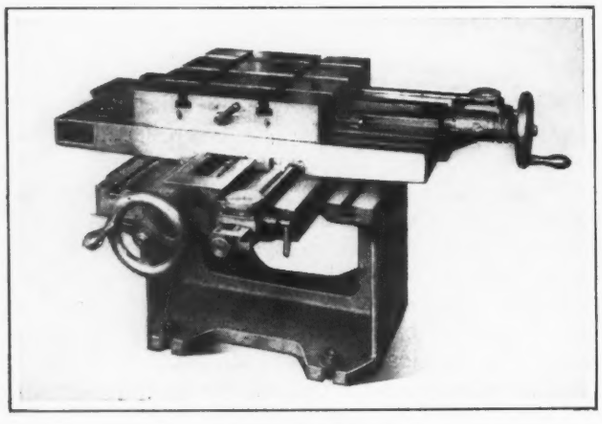
the lubricator mechanism is driven by a spindle of the machine, so that it delivers lubricant automatically to every important bearing.

Another automatic lubricator manufactured by the same company has been applied to a punch press and to a woodworking machine.

JOHNSON JIG SPACER

A device designed primarily for application to any standard vertical milling or upright drilling machine to facilitate the spacing of holes in the construction of jigs, fixtures, and similar parts of high accuracy, has been placed on the market by the Trundle Engineering Co., Card Building, 118 St. Clair Ave., East, Cleveland, Ohio. This device, known as the Johnson jig spacer, may also be used on planers, shapers, or slotters. It consists essentially of a base on which two slides are mounted at right angles to each other. Accurate control of spacings is obtained by moving these slides to and fro in conjunction with standard fixed-end measuring gages and dial indicators. The construction of the equipment is such that accuracy does not depend upon the feed-screws of the slides.

The clamps used to lock the slides in position are entirely independent of the gibs and do not disturb the gib settings. They consist of an arrangement of levers that operate in a T-slot and clamp the flat surfaces of the slides in such a manner that there is no distortion that would affect settings or alignment. The total longitudinal travel is 15 inches, and the transverse travel, 12 inches—15 inches with 3 inches of overhang. The worktable measures 16 by 16 inches, and the floor space required is 37 by 45 inches. The illustration shows this spacer on a special table.

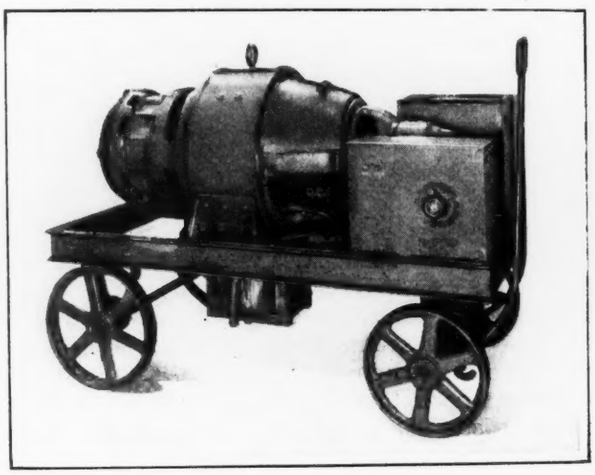


Johnson Jig Spacer

WESTINGHOUSE ARC-WELDING EQUIPMENT

Two arc welders, one of which is intended for automatically welding longitudinal seams, while the other is of a single-operator type, have recently been developed by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The automatic seam welder is intended for use in manufacturing pipe and tanks from sheet steel or plate from 1/16 to 3/8 inch thick. The standard machine will handle pipe and tank barrels varying in diameter from 10 to 40 inches and having a maximum length of 8 feet. Greater diameters may be accommodated by providing a pit in the floor.

The machine consists of two parts, a clamping mechanism for holding the material to be welded



Single-operator 300-ampere Arc Welder

and automatic traveling welding equipment. The clamping mechanism is attached to a horizontal bridge consisting of two parallel beams about 4 inches apart. Below the space between these beams, and parallel to them, projects a standard rail as a cantilever from the base. The tank to be welded is slipped over the free end of this rail and held tight by compressed air clamps, with the seam to be welded extending along the copper backing strip on the rail. On top of the two parallel beams there is a machined track for the welder.

The latter consists of a carriage containing a driving motor, an automatic arc welder, and a reel of welding wire. The carriage is driven in either direction along the bridge through reduction gearing which gives speeds of from 5 to 50 inches per minute. The welding current can be varied from 175 to 300 amperes. This machine can also be furnished in a modified form for work as small as 6 inches in diameter and up to 20 feet long. In cases requiring special clamping equipment, the traveling welder is furnished as a separate unit.

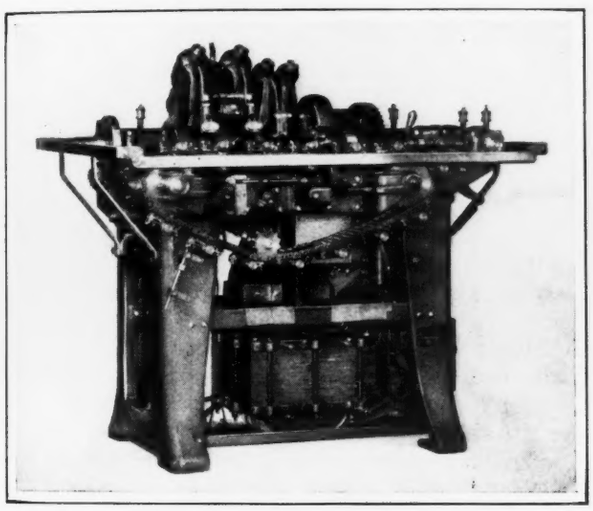
Simplicity of operation is the feature claimed for the single-operator arc welder here illustrated. To cover a wide range of applications, this welder is built in three ratings of 200, 300, and 400 amperes, respectively. The operation of the welder

requires only two simple movements—pushing a button to start the motor generator set, and turning the handle of a rheostat to adjust the welding current to the desired value.

The set is built either as a stationary or a portable unit. In the case of the stationary unit, the running gear is omitted and the stabilizing reactor is mounted separately. Owing to the constant current characteristic of the generator, the arc is stable over a wide range of welding current.

THOMSON AUTOMATIC ELECTRIC WELDER

An automatic machine for welding small rings at rates ranging from twenty to thirty per minute was recently built by the Thomson Electric Welding Co., Lynn, Mass. This machine is equipped with a water-cooled transformer having a capacity of 100 kilovolt amperes. It was built for welding rings from 1 1/4 to 2 1/2 inches inside diameter,



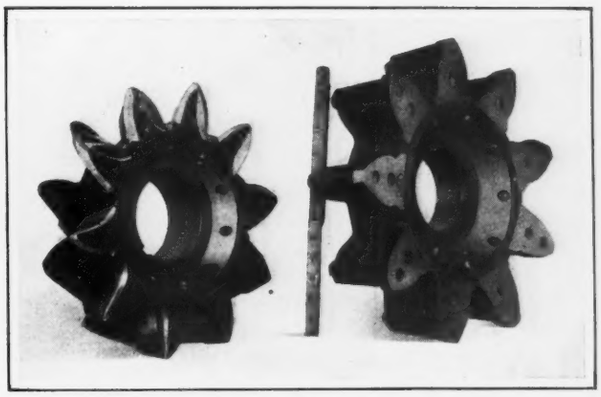
Thomson Electric Ring Welder of Automatic Design

of wire from 1/4 to 5/16 inch in diameter, or rings from 2 1/2 to 4 3/4 inches inside diameter, of wire up to 7/16 inch in diameter. There is one set of location fingers for rings between 1 1/4 and 2 1/2 inches in diameter and another set for larger rings.

The welder is driven through a belt and a gear reduction unit. The clamps, push-up, current control, and burr-removing device are fully automatic. The operation is continuous, the operator merely inserting rings in jigs mounted on an endless chain passing along the front of the machine. The gross weight of the welder is approximately 4500 pounds.

FARREL GEAR CUTTERS WITH INSERTED BLADES

Gear cutters for teeth of 1 3/4 diametral pitch and larger are now made by the Farrel Foundry & Machine Co., 344 Vulcan St., Buffalo, N. Y., with cast- or forged-steel bodies and high-speed steel blades. The blades are held in position by wedges and bolts, as illustrated. In making the blades, they are first roughed out to the approximate tooth shape, then hardened, and finally finish-ground in position on the body. By grinding the blades after



Farrel Gear Cutters with Interchangeable Blades

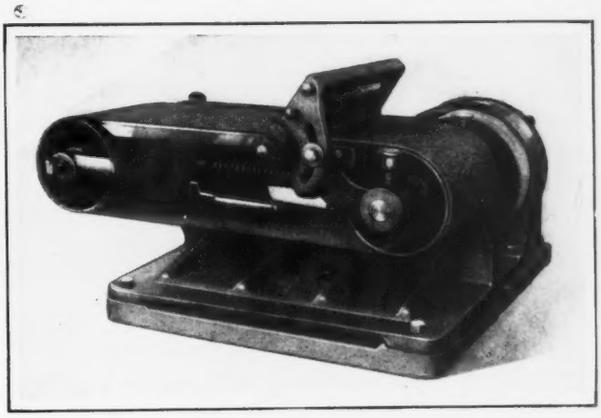
they have been assembled, the cutter can be produced with the accuracy of a cutter made from one piece of tool steel.

The principal advantages claimed for the new design of cutters are as follows: (1) The high-speed steel blades, being comparatively small, can easily be hardened thoroughly and evenly. (2) If the blades encounter local hard spots in the material which they are cutting and one or two are damaged, it is a simple matter to replace them with new blades. (3) The cutters are economical because the body and the holding devices are permanent and because the blades can be machined in large quantities, thereby conserving the amount of material used and cheapening the cost of roughing operations. (4) Accuracy can easily be maintained, because the cutter blades, which regulate the tooth shape, are finished in position on the body. These cutters were shown at the Cleveland Exposition.

WALLS ABRASIVE-BAND GRINDER

An abrasive-band grinder or sander equipped with an individual motor drive has been placed on the market by the Walls Sales Corporation, 96 Warren St., New York City. This "Simplex B-M" grinder has the regular quick-change band feature, by which the band can be changed by pulling out the lever to draw in one pulley. The band lies flat on the table after the lever is again released.

The table over which the band operates is 18 inches long by 10 inches wide. Special fixtures may be fastened on this table. The abrasive band is 8 inches wide by 61 inches long, and may be



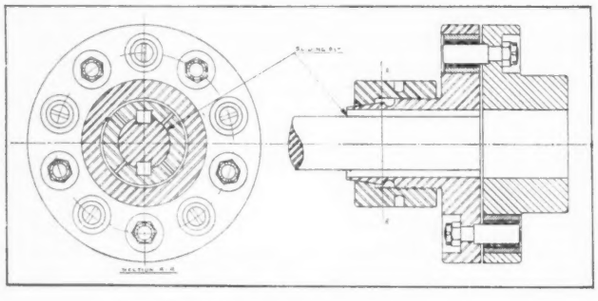
Walls Motor-driven Abrasive-band Grinder

brought into any fixed position by adjusting two thumb-screws at the rear of the machine. The bevel attachment may be removed. The one-horsepower motor which furnishes the power is connected to the grinder through a direct internal gear drive. The speed of the grinder is 875 revolutions per minute, and the weight, about 425 pounds.

AJAX TENSION-SLEEVE FLEXIBLE COUPLING

Quick disconnection of driving shafts to facilitate changes in a hook-up or to permit using one motor for driving different machines at different times, is possible by means of a tension-sleeve flexible coupling recently developed by the Ajax Flexible Coupling Co., Westfield, N. Y.

This coupling is so made that the flange attached to the driven shaft is readily removable. The removable half, as may be seen from the illustration, is made with an extended split hub on the driving flange, the hub being tapered and threaded on the outside. A collar that is made to fit over the threaded hub is screwed up to tighten the hub on the shaft, the hub being further held in place by set-screws which are fitted over two sliding keys.



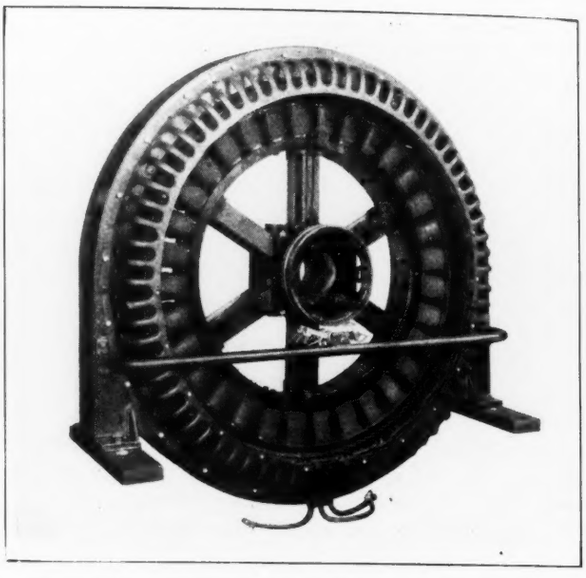
Ajax Tension-sleeve Flexible Coupling

The coupling absorbs shocks and overloads, allows free end-float of motor shafts, and insures against undue wear of bearings or motor armatures.

WESTINGHOUSE ARC-WELDED AND LINE-START MOTORS

A low-speed synchronous motor of arc-welded construction has recently been placed on the market by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The parts of this type HR motor have been especially designed for ease in handling and in field assembling. Among the features emphasized are a starting torque of 50 per cent and a pull-in torque of 40 per cent. The shape of the rotor arms is such that a large amount of air is set in motion. This cooling air not only passes through stator coils, but also passes over a large area of the stator laminations. A means of varying the flywheel effect is an important feature, six possible values of flywheel effect being available by means of different weight rings bolted to the rotor rim. The motor is intended for driving slow-speed machinery.

The Westinghouse Electric & Mfg. Co. has also recently developed a line-start motor operated by a push-button line starter. This motor is intended for driving compressors, plunger pumps, conveyors, and similar equipment where a heavy load



Westinghouse Low-speed Synchronous Motor of Arc-welded Construction

is to be started. A manual starter may be used with this motor, but it is simpler and safer to employ the new line starter.

RICHARD INTERCHANGEABLE PIERCING PUNCHES AND DIES

Interchangeable piercing punches, dies, and their accessories are manufactured in a complete line by the Richard Brothers Die Works, 1560-74 E. Milwaukee Ave., Detroit, Mich. The line includes round, oblong, and square punches and dies, as well as retainers, backing plates, dowel-pins, and retaining plates of various styles. Special punches are also manufactured with interchangeable features. With the various standard parts, it is possible to build up a complete piercing die from stock. Worn out or broken punches and dies can be easily replaced.

Fig. 1 shows a typical set comprising a round punch and die with their retainers. The retainers

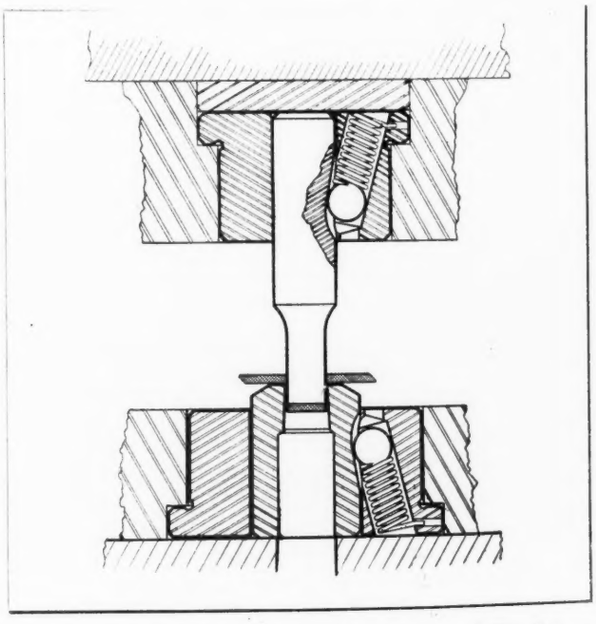


Fig. 1. Richard Interchangeable Punch and Die Set

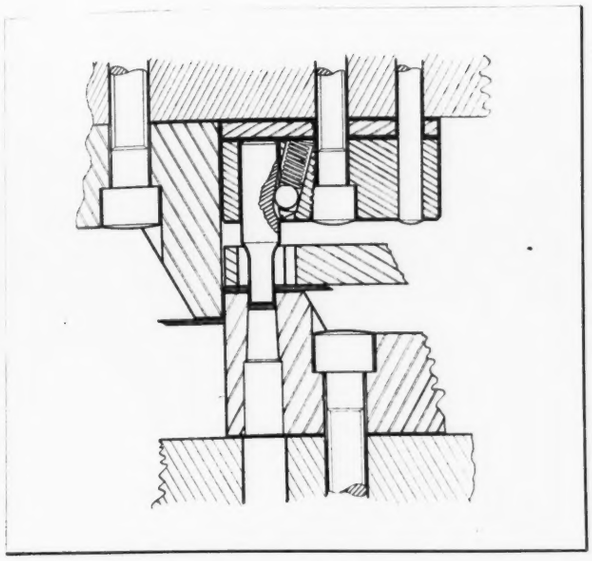


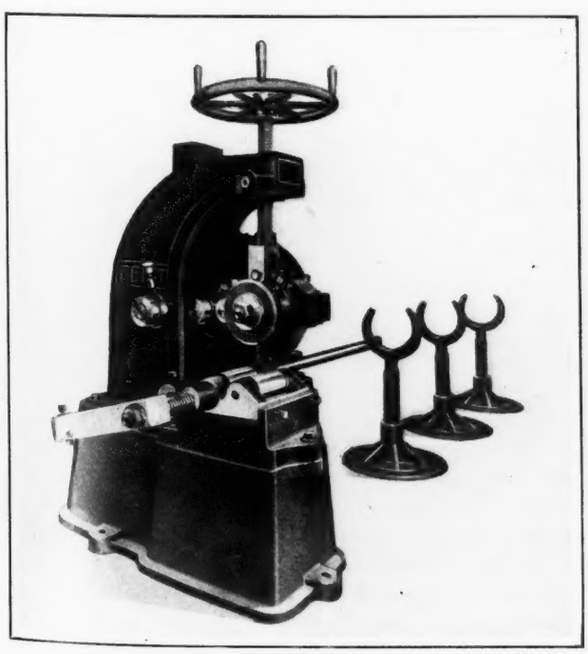
Fig. 2. Method of Using an End Retainer for a Punch

are press fits in the punch and die plates, the latter being secured to the punch-holder and die shoe, respectively, in the ordinary manner with screws and dowel-pins. Both the punch and die are held in their retainers by means of a ball. They can be instantly removed by releasing the ball and inserting a drift into the small aperture provided.

Fig. 2 illustrates primarily the application of an end retainer for a punch. Both this and the square type of retainer differ from the round style in that they are self-contained, which facilitates installation.

GEIST ROLLER PIPE CUTTERS

Two new heavy-duty roller pipe cutters, Nos. 4 and 6, have been added to the line built by the Geist Mfg. Co., Waynesboro, Pa. The No. 4 machine has a capacity for handling from 1 1/2- to 4-inch pipe, but by adding a small cage of rollers, it can be used for cutting off pipe from 1/2 to 4 inches. The standard capacity of the No. 6 machine is for pipe from 3 1/2 to 6 inches, but by the addition of the small cage of rollers, this machine will cut off from 1- to 6-inch pipe.



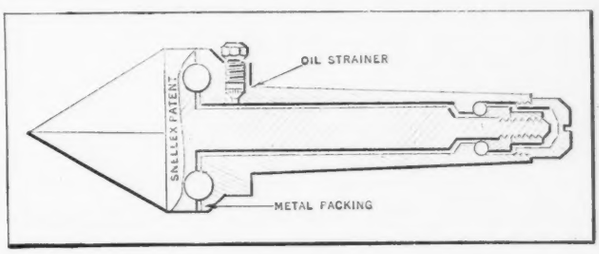
Geist High-production Roller Pipe Cutter

The cutter is made from tool steel, heat-treated, and can be reground when dull. An adjustable cap on the cutter shaft bearing provides for taking up wear. The cutter is lowered to the pipe by means of the handwheel at the top of the machine. The rollers are made from tempered tool steel and are carried in roller bearings. The cage that supports the rollers is bolted to the machine bed.

The length gage is adjustable for different sizes and different lengths of pipe up to 40 inches. Parts coming in contact with the revolving pipe are hardened so as to resist wear. The machine may be equipped with a belt or motor drive, a three-horsepower motor being required for the No. 4 machine and a five-horsepower motor, for the No. 6 machine. In motor drives, power is transmitted from the motor to the machine through gears. The Landis Machine Co., Waynesboro, Pa., has the exclusive sale of these machines.

SNELLEX HEAVY-DUTY CENTER

A heavy-duty center has been added to the line of ball-bearing centers made by the Snellex Mfg. Co., Rochester, N. Y. The principal feature of this center is a large front ball bearing of new design. The ball races are cut extra deep, so that the balls are almost completely embraced. This is said to insure the greatest possible capacity for both radial and thrust loads.

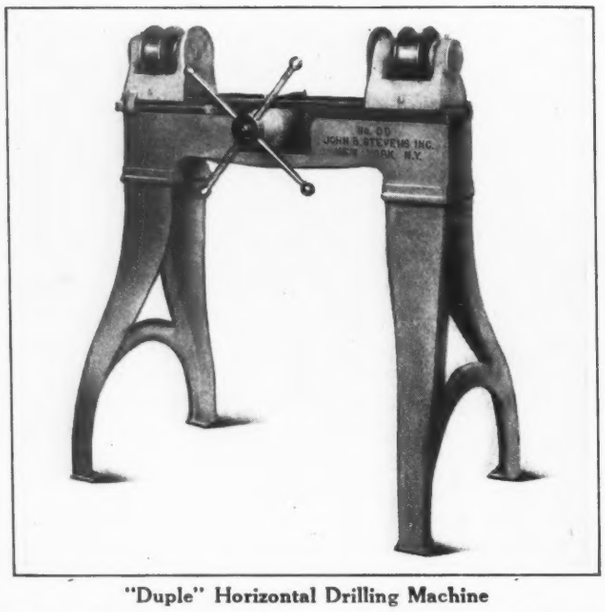


Snellex Heavy-duty Ball-bearing Center

Another feature is the metal packing which closes up the space between the rotating center point and the tapered sleeve, as illustrated. This packing prevents chips and dirt from entering the ball bearing. A strainer at the bottom of the oil-hole removes solids from the oil. The taper shank is hardened and ground. The center point can be made to suit the requirements of turning, grinding, milling, and spinning metal or turning wood.

STEVENS DOUBLE-SPINDLE HORIZONTAL DRILLING MACHINE

Three sizes of a "Duple" horizontal machine having opposed spindles for reaming, chamfering, beveling, counterboring, and drilling operations have been placed on the market by John B. Stevens, Inc., 27 Cleveland Place, New York City. The illustration shows the smallest or No. 00 size without a pan or fixture table. The spindles of these machines revolve in ball bearings arranged to take both radial and thrust loads.



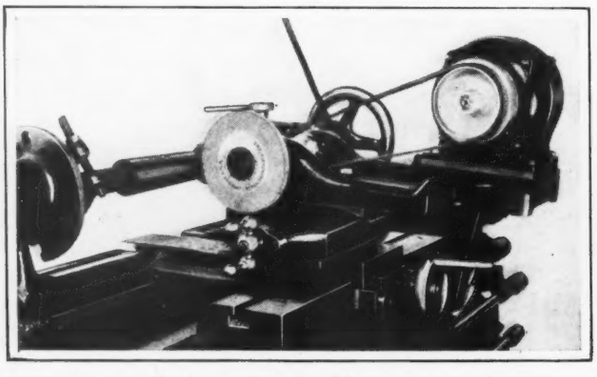
"Duple" Horizontal Drilling Machine

The front faces of the heads are machined to permit the attachment of multiple-spindle drill heads or die- and tapper-head bodies. A centrally located pilot wheel is used to move both heads simultaneously. Means are provided for adjusting either head independently of the other.

ATLANTIC TOOLPOST GRINDER

A universal toolpost grinder for internal, external, and surface grinding is being placed on the market by the Atlantic Machine & Tool Co., 28 Canfield St., Orange, N. J. For surface grinding, a cup-wheel is used and no spindle extension is necessary. For external grinding, the wheel is also mounted directly on the spindle, but for internal grinding, two extension spindles are provided. Holes 5/8 inch in diameter and up can be ground.

The spindle has a front double-taper bearing, while the rear bearing is split to provide for adjustment. A ball thrust bearing at the rear is equipped with two check-nuts for adjusting purposes. The spindle is driven by a constant-speed 1/4-horsepower alternating- or direct-current motor, running at either 3500 or 5500 revolutions per minute. The motor is mounted on a slide which may be adjusted to take care of belt elongation. This grinder is adaptable to all lathes from the 12-inch size upward, and can be mounted on a shaper or planer for surface grinding operations.

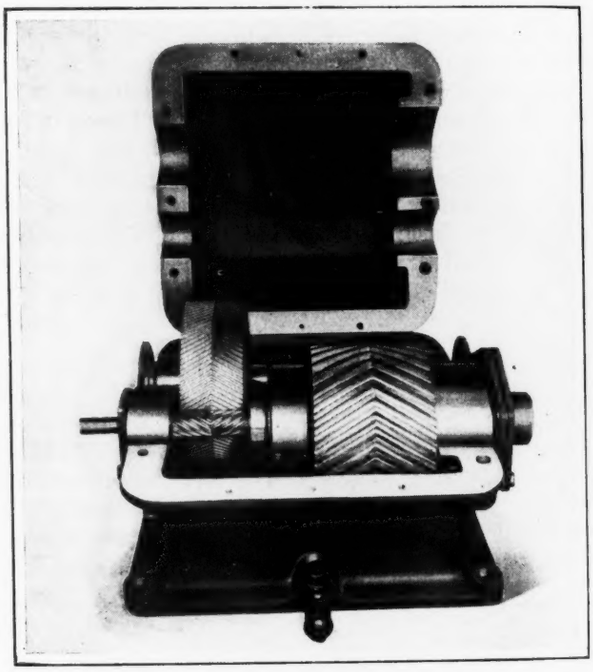


Atlantic Toolpost Grinder Mounted on a Lathe

LINK-BELT SPEED REDUCERS

Speed reducers employing Sykes herringbone gears have been brought out in three standard units by the Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill. These units cover a wide range of ratios and capacities for application in all classes of light or heavy service. The single-reduction unit is designated as type S and is built in ratios up to 10 to 1. Types D and DV are double-reduction units, type D being designed for heavy-duty service and ratios of from 10 to 1 up to 80 to 1. Type DV is designed for light-duty service, with ratios ranging from 10 to 1 up to 130 to 1. A type D unit is shown in the illustration with the cover lifted.

Timken tapered roller bearings are provided to protect the gears from thrust loads coming from outside drives or misaligned couplings. They also provide for overhung loads, so that an outboard bearing is unnecessary for standard projections. The gears rotate in a large oil reservoir, and all



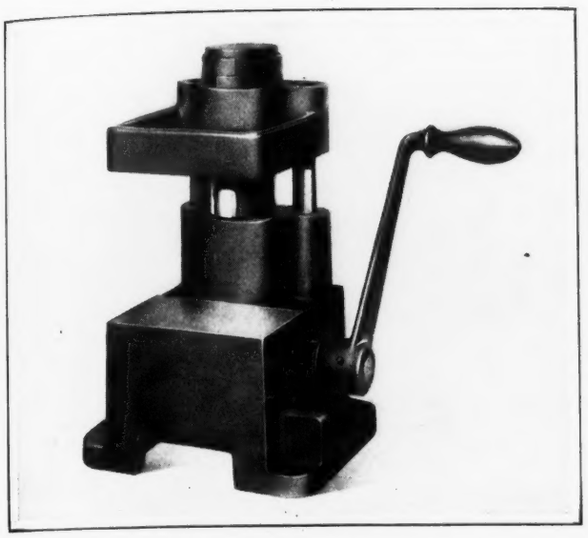
Link-Belt Speed Reducer with Sykes Herringbone Gears

bearings are splash lubricated. Special oil baffles at shaft projections keep out dust and retain the oil. These reducers can be equipped with a motor drive, in which case the motor and reducer may be mounted on a single baseplate which maintains alignment between the two.

SIEWEK DRILL JIGS

Drill jigs of four different types which can be adapted to various jobs are being placed on the market by the Siewek Tool & Die Co., 10232 Woodward Ave., Detroit, Mich. The accompanying illustration shows type 1, which has a single post. Jigs are also built with two or more posts. Interchangeable bushing plates can be provided to slide up and down on the posts when they are actuated by the handle.

One of the features of these jigs is the cushion clamping arrangement. After work has been



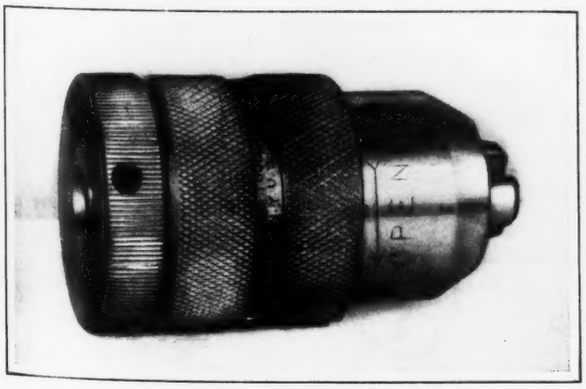
Siewek Drill Jig with Spring Clamping Feature

placed on the anvil of the jig, the bushing plate and its component parts are permitted to descend by gravity until the adapter held in the bushing plate comes in contact with the work. Then the handle is operated to release a coil spring within the post which exerts pressure up to 400 pounds upon the work.

"ETTCO" KEYLESS DRILL CHUCK

A keyless self-tightening drill chuck of the construction here illustrated has been added to the line of chucks manufactured by the Eastern Tube & Tool Co., 590 Johnson Ave., Brooklyn, N. Y. This chuck does not need to be tightened by the operator to hold the drill securely, it being merely necessary to close the chuck by hand. After the work is started, the chuck grips itself, and as the drill point goes deeper, the gripping action increases with the load. It is claimed that no matter how tight the chuck grips, it can be released by hand with a quick twist of the wrist.

This chuck has been designed primarily for use on electric and air drills, but can also be used to advantage with flexible shaft units. The collar at the top of the chuck is held by the operator to prevent electric or air drills from turning when opening or closing the chuck. It eliminates certain abuses to which electric drills are often subjected, such as using a nail in ventilating holes to prevent the armature from turning. This type of chuck with the holding collar is furnished with any thread or taper to fit standard makes of electric and air drills.



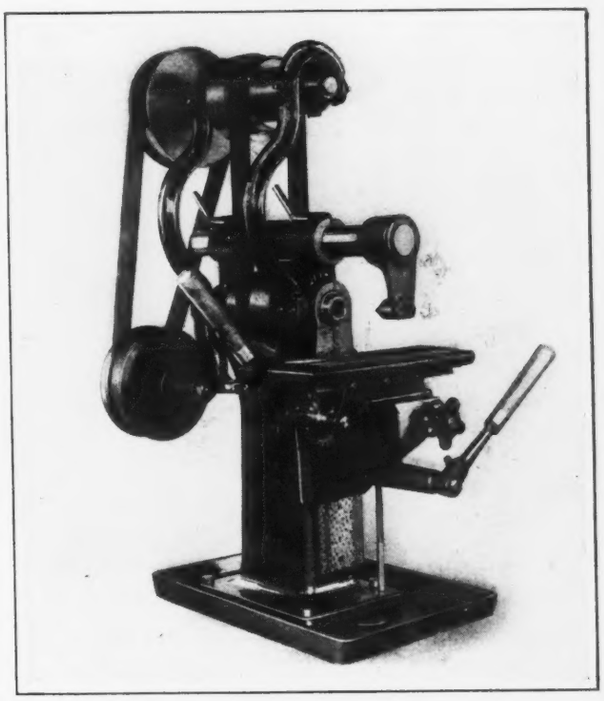
"Ettco" Keyless Self-tightening Drill Chuck

BURKE MOTOR-DRIVEN BENCH MILLING MACHINES

Two motor-driven bench milling machines, Nos. 3 and 4, have been added to the line built by the Burke Machine Tool Co., 516 Sandusky St., Conneaut, Ohio. These machines are of the same design except that one has a hand feed and the other a power feed.

The motor, which may be located at any convenient place, drives a two-step cone pulley mounted on the back of the machine. From this cone pulley, power is delivered to a countershaft, equipped with ball bearings. A 1/2-horsepower heavy-duty motor gives ample power for these machines.

The machines have a longitudinal table feed of 8 inches and a transverse feed of 3 inches. The maximum distance between the center of the spindle and the table is 8 inches, while the working surface of the table measures 3 1/2 by 16 inches.



Burke Bench Milling Machine Equipped with Motor Drive

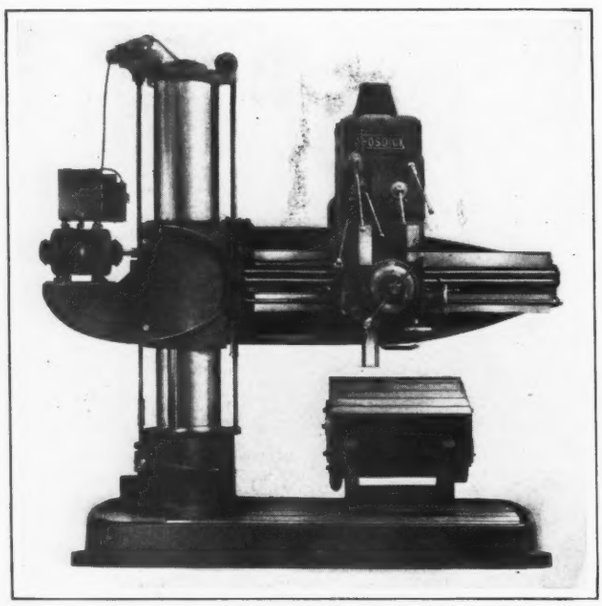
FOSDICK HEAVY-DUTY RADIAL DRILLING MACHINES

In a line of heavy-duty radial drilling machines recently introduced to the trade by the Fosdick Machine Tool Co., Cincinnati, Ohio, all movements are controlled at the head. The line comprises 5-, 6-, and 7-foot sizes. In each machine, a power rapid traverse for the head is built into the arm, and this traverse unit is automatically lubricated. The power column clamp is operated from the head through a push-button. There are no dangling wires from the head to the top of the column, as the wires are automatically wound up on a reel. A clamping motor is furnished, and the power

clamp unit is automatically lubricated. It is impossible to elevate or lower the arm when it is clamped.

Thirty-six spindle speeds are available, ranging either from 14 to 1010 revolutions per minute or from 20 to 1406 revolutions per minute. They are obtained through seventeen sliding gears operated by three levers. Eighteen selective feeds are obtainable with two levers, the feeds ranging from 0.003 to 0.125 inch per revolution, including pipe tap leads for threads of 8, 11 1/2, and 14 per inch. Both the speed and feed units are lubricated automatically. There is a safety interlock for feeds at high speeds, and a safety knock-out for the feed at both extremes of the spindle movements.

The depth dial is divided into even inches. There may be a full spindle travel without readjusting the setting of this dial. Multiple disk start, stop, and reverse frictions are included in the spindle clutch, and each unit is adjustable from the outside of the case by means of a single nut.

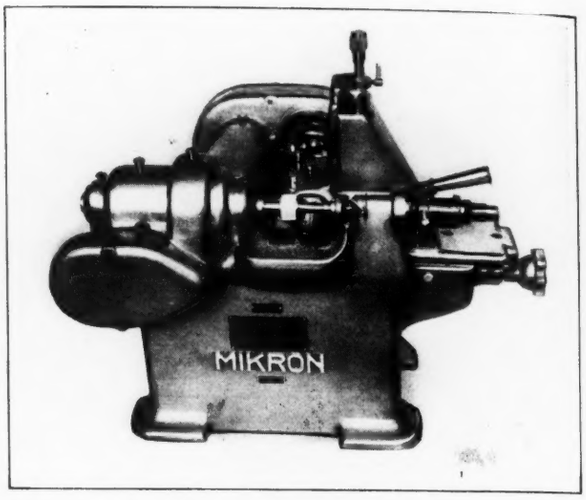


Fosdick Radial Drilling Machine with All Controls at the Head

A constant-speed motor drives the spindle, elevates the arm, and operates the head power traverse. The table is of a tilting design, and can be clamped at any angle. Ball and tapered roller bearings are provided from the motor to the spindle nose, and a roller bearing insures easy swinging of the arm.

"MIKRON" BENCH-TYPE GEAR-HOBBING MACHINE

A bench-type gear and pinion hobbing machine known as the "Mikron No. 79" is being introduced on the American market by the Triplex Machine Tool Co., 50 Church St., New York City. This machine may be employed for hobbing gears and pinions up to 1 1/2 inches in diameter arranged on an arbor in lengths up to 1 1/2 inches. It is used in the manufacture of brass and steel gears for meters, clocks, watches, counting machines, phonographs, etc. Gears having from 6 to 500 teeth may be cut by using change-gears.



"Mikron" Hobbing Machine for Small Gears and Pinions

All gears of the machine are enclosed, the change-gears being made accessible by removing cover plates. In practice, a spare arbor is filled with blanks ready to replace those being cut. The feed of the hob can be varied from 0.004 to 0.030 inch per revolution of the work, to suit the material being cut. The approximate weight of the machine, equipped with a countershaft, is 125 pounds, and the bench space required is about 20 by 22 inches.

"FUZON" ELECTRIC WELDER AND ELECTRODE-HOLDER

The portable direct-current welder here illustrated has recently been brought out by the Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill. This equipment was shown at the Detroit Exposition. It is furnished in a number of styles and sizes to meet special conditions, and is made stationary as well as portable. It may be driven by an electric motor or gas engine or from a lineshaft. Certain types embody two generators and one motor, permitting one or two operators to work from the same set. Stabilizing is accomplished entirely by the generator windings, this feature being covered by Hansen patents.

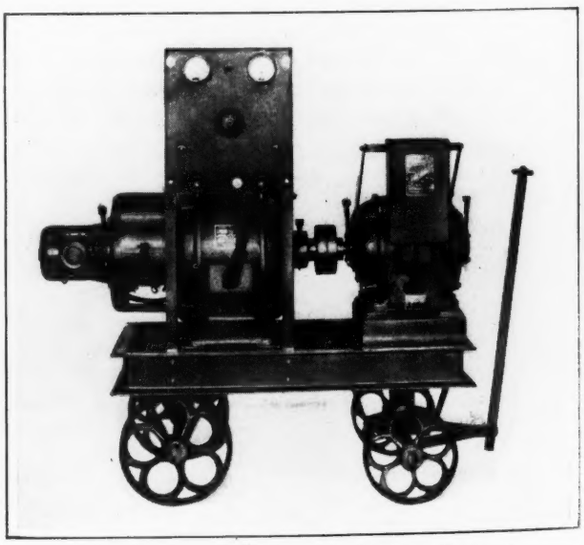


Fig. 1. "Fuzon" Portable Electric Welder

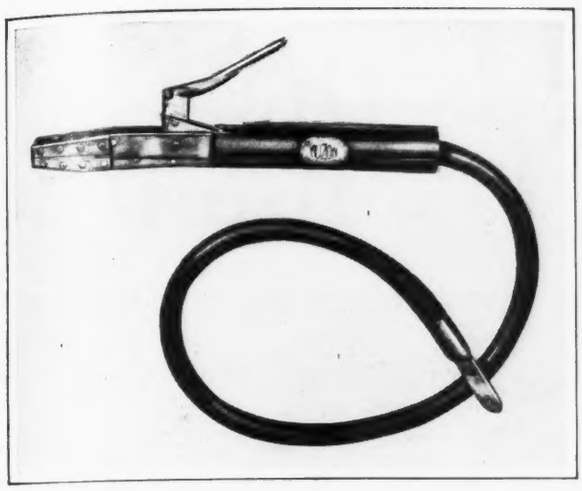


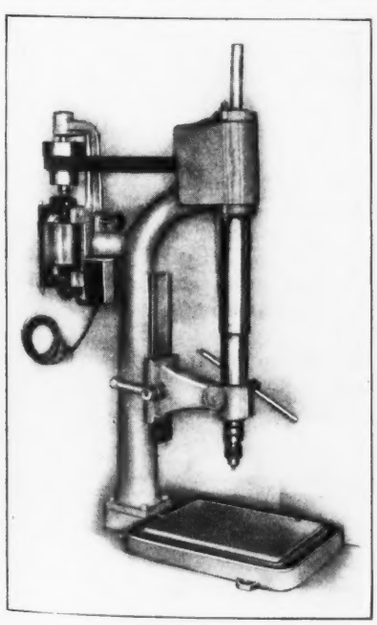
Fig. 2. Electrode-holder Made by the Fusion Welding Corporation

Voltage regulation is automatic and covers a wide range. Carbon arc welding and cutting can be carried on by merely substituting a carbon electrode for the metallic electrode. Instruments are placed where they can be quickly read. The generator may readily be adjusted for arc stability or for starting current, which results in a wide range of application. For example, thin sections can be welded, and by a simple adjustment, the excessive starting penetration required for heavy sections can be obtained.

Fig. 2 shows an electrode-holder made by the same concern. When the electrode is placed in this holder, the jaws clamp and the electrode is automatically pushed forward. This movement scrapes all surface materials from the four points of contact, thus insuring a good contact that eliminates overheating. The holder weighs 2 pounds.

CANEDY-OTTO DRILLING MACHINE

A 14-inch high-speed sensitive drilling machine of the bench type has been recently brought out by the Canedy-Otto Mfg. Co., Chicago Heights, Ill. This machine, which embodies a sliding head, is intended for drilling holes up to 5/16 inch in diameter. Power is taken from a vertical type motor which is mounted in such a manner that it can be conveniently moved in and out to obtain the desired belt tension and then clamped in position. The sliding head and an adjustable spindle stop, combined, give a large scope for drilling. Power is taken from a lamp socket.



Canedy-Otto Sensitive Bench Drilling Machine

Spindle speeds of 3400, 5600, and 10,000 revolutions per minute are obtainable. The vertical adjustment of the head is 7 1/2 inches; the travel of the spindle, 3 1/4 inches; the maximum distance from the bottom of the chuck to the table, 10 1/2 inches; the distance from the column face to the spindle center, 7 1/4 inches; and the net weight of the machine, 180 pounds.

GREENFIELD UNIVERSAL TOOL AND CUTTER GRINDER

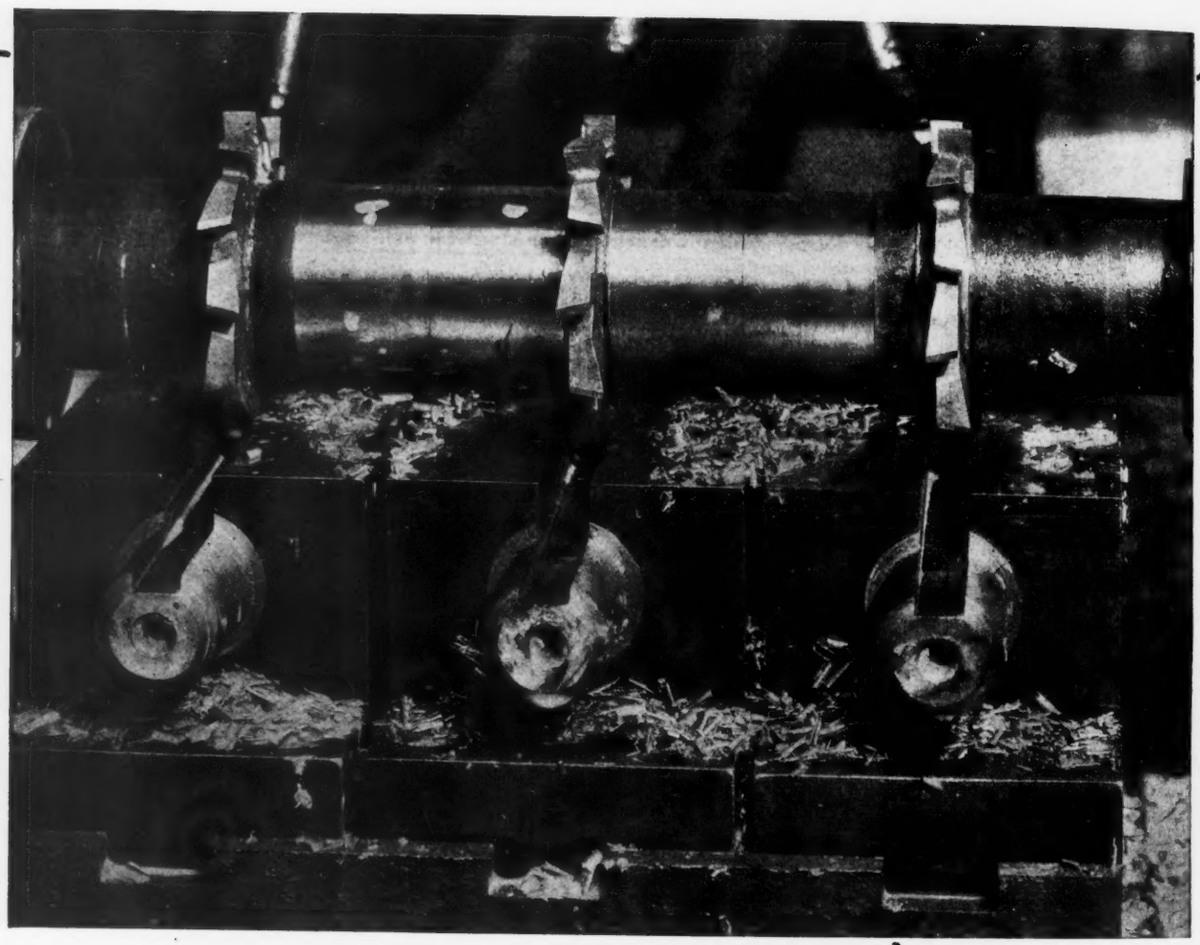
A universal tool and cutter grinder that does not employ a countershaft or belting is being introduced to the trade by the Greenfield Tap & Die Corporation, Greenfield, Mass. This machine was exhibited at the Cleveland show. The entire machine is driven by one motor which is integral with the wheel-head. The motor is of 1/2 horsepower capacity and runs at 3600 revolutions per minute. It is intended for 60-cycle, 220-volt alternating current.

Greenfield Universal Tool and Cutter Grinder

The drive to the headstock when the plain grinding attachment is being used, and to the chuck for internal work, is accomplished through a flexible shaft and a small worm-gear box, which gives a reduced speed to the chuck and headstock of about 480 revolutions per minute. The use of the flexible drive shaft eliminates the need of a second motor on the headstock and results in a compact design free from vibration.

The flexible shaft housing can be fixed to the motor housing quickly, and is held in place by means of three screws. The drive is through a square pin, which fits a slot in the end of a special Morse taper shank that replaces the grinding

If the power is there—
use it for p



A production increase of 200% was the result when Brown & Sharpe Staggered Tooth Side Milling Cutters were put on this job of milling keyways in chrome nickel steel shafts. This increase is based on three factors.

1. The design and durability of the cutters made it possible to double the feed.

2. Because of the freer cutting action and lower power consumption of the cutters, it was possible to add an extra cutter to the gang, getting higher production from the same machine equipment.

3. The durability of the cutters made it possible to cut four times as many keyways per sharpening as the previous cutters. Much idle machine time formerly caused by changing cutters was eliminated.

Brown & Sharpe Products

Milling Machines
Grinding Machines
Gear Cutting Machines
Screw Machines
Cutters and Hobs
Machinist's Tools
Gears Cut to Order

or production

WHEN Brown & Sharpe Cutters were put on the job shown at the left, the gain in production over the previous set-up was such that one machine was able to do the work which formerly required three.

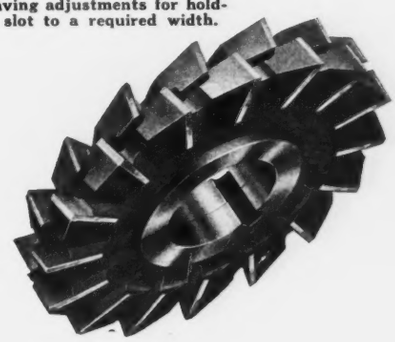
This case demonstrates the alarming amount of power that can be *wasted* in nursing along poorly designed, inferior cutters.

Don't allow set-ups to exist in your plant in which a similar waste of power could take place with resultant low production. Let our representative recommend cutters that will enable you to get the maximum production obtainable from the machine.

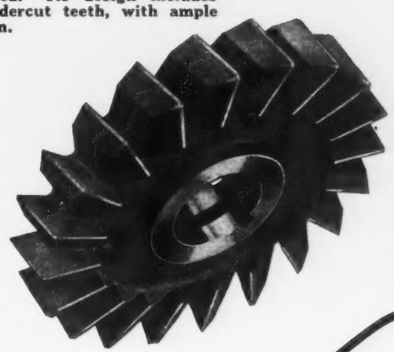
Three Popular Brown & Sharpe Cutters

The alternate right- and left-hand spiral teeth with large chip spaces give these Staggered Tooth Side Milling Cutters ability to remove metal rapidly when cutting deep slots—up to the hub, if desired.

In addition to their efficiency because of the spiral angle and under-cut teeth, these Interlocking Cutters have the added advantage of finishing the bottom of slots, while having adjustments for holding the slot to a required width.



The Single Side Side Milling Cutter is a high production cutter designed for use when one side only is required. Its design includes spiral undercut teeth, with ample chip room.



Be sure to keep a copy of Catalog No. 30 on hand for cutter reference. If you haven't received a copy, write for one today.

BROWN & SHARPE

BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

wheel holder in the motor spindle. The internal grinding attachment itself is of improved design, and is driven by belt from the motor head, the speed of the grinding spindle being approximately 13,000 revolutions per minute.

The base and standard of this machine are combined in a single casting. Except for the headstock used in plain grinding and the chuck employed in internal grinding, all attachments of this machine are the same as those used on the Greenfield No. 2 internal grinder.

GENERAL ELECTRIC MELTING POT

A small electric melting pot for solder, lead, babbitt, tin, etc., which has a capacity of from 27 to 40 pounds, according to the metal to be melted, has recently been placed on the market by the General Electric Co., Schenectady, N. Y. This pot may be operated on either 110- or 220-volt alternating or direct current circuits, and is made in two ratings of 750 and 1000 watts, respectively.

General Electric Melting Pot

The pot consists of a sheet-steel cylindrical casing, 10 inches deep by 9 inches in diameter, in which is supported a cast-iron crucible, 4 inches deep by 6 inches inside diameter. The heating unit is of the cast-in sheet-wire type. The leads of the unit are brought over the top of the pot into a connection box fixed to the unit itself. This pot is intended for use at temperatures not exceeding 950 degrees F.

OBITUARIES

FRANK C. WIGHT, editor of the *Engineering-News-Record* and president of the National Conference of Business Paper Editors, died September 18 at his home in Summit, N. J. Mr. Wight joined the staff of the *Engineering News* in 1906, and was appointed editor of the *Engineering-News-Record* in 1924. He was a member of the American Society of Civil Engineers, the Cornell Society of Engineers, the American Concrete Institute and other bodies interested in the advancement of the professions of civil engineering and technical journalism.

JOHN M. DUNDON, assistant works manager of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., died at his summer home near Buffalo, August 14, at the age of forty-eight. Mr. Dundon had been employed by the Pierce-Arrow company for twenty years. He was at first foreman in the toolroom, and during the war became chief of the aircraft work in which the factory was then engaged. After the armistice, he was promoted to superintendent of manufacturing, and later advanced to the position of assistant works manager.

ARTHUR F. MERRY, mechanical superintendent of the Erie Works of the General Electric Co., died August 7 after a two weeks illness. Mr. Merry was sixty-three years old. For the last twenty years he had been with the General Electric Co., first going to the Pittsfield Works in 1907, and then being transferred to the Erie Works in 1911, at which latter place he occupied the position of mechanical superintendent.

PERSONALS

LUTHER H. BOSNIAN has been appointed superintendent of the Park St. plant of the Chain Belt Co., Milwaukee, Wis., manufacturer of conveyors, traveling water screens, chain, and concrete mixers. Mr. Bosnian has been connected with the Chain Belt Co.'s production department for the last eight years.

Thomas S. Poole

THOMAS S. POOLE has been appointed direct factory representative for the southern states territory by the Whitman-Barnes-Detroit Corporation, succeeding FRED A. HARDIN. Prior to the merger of the Whitman Barnes Mfg. Co. and the Detroit Twist Drill Co. last September, Mr. Poole was associated for several years with the Detroit Twist Drill Co., and since that time he has been representing the new corporation.

J. C. ROWETT has been appointed factory district representative for the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., for the state of Minnesota and northwestern Wisconsin. Mr. Rowett will make his headquarters at 406 Sixth Ave., S., Minneapolis, Minn.

FERNAND TURRETTINI, director-general of the Societe Genevoise D' Instruments de Physique of Geneva, Switzerland, arrived in the United States September 14 to spend five or six weeks in this country. He has visited the Cleveland and Detroit Shows and is planning to visit a number of manufacturing plants.

CHARLES A. PERRYMAN, formerly sales manager of the wire rope department of the Wickwire Spencer Steel Co., Inc., is now associated with the American Cable Co., maker of the "Tru-Lay" wire rope, in the capacity of assistant sales manager. Mr. Perryman will make his headquarters at 105 Hudson St., New York City.

ARTHUR S. PIERCE, formerly associated with the Boston office of Manning, Maxwell & Moore, Inc., is now direct factory sales engineer in the Boston territory for the Barnes Drill Co., Rockford, Ill. Mr. Pierce will also represent the Sundstrand Machine Tool Co. in a similar capacity. His home address is Melrose, Mass.

A. B. DETTMER, formerly plant engineer for the American La France Fire Engine Co., Inc., Elmira, N. Y., has been appointed works manager of the National Tool Co., Cleveland, Ohio. Fred Freidle, who was Mr. Dettmer's assistant in his former connection, has also joined the National Tool Co. in the capacity of assistant works manager.

H. V. GREENWOOD, formerly sales manager of the Baldwin Chain Co., recently joined the sales organization of the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., as Michigan district representative. Mr. Greenwood will make his headquarters in Chicago, but will cover the state of Michigan, with the exception of the Detroit and Grand Rapids territory.

CLAUDE A. BULKELEY has become associated with the Niagara Blower Co., 673 Ontario St., Buffalo, N. Y., as chief engineer. Mr. Bulkeley will have direct supervision over the design and installation of all air conditioning equipment, and general supervision over all air engineering work carried on by the company. He was for ten years previously, supervisory engineer of the mechanical experimental division of E. I. duPont de Nemours & Co., Wilmington, Del.

LARS G. NILSON, formerly chief engineer of the Nilson-Miller Corporation, of Hoboken, N. J., has entered consulting engineering practice. Mr. Nilson, who has been active in the Nilson-Miller Corporation for the last eighteen years, will still serve that company as a consultant, and retains his interest in it as a director and stockholder. In his consulting practice, he will devote himself to the design and development of special machinery and devices. His business address is 1219 Garden St., Hoboken, N. J.